GEOLOGY AND GEOGRAPHY
OF
KARACHI AND ITS NEIGHBOURHOOD

BY

MANECK B. PITHAWALLA, D. Sc., F.G.S.

RESEARCH CERTIFICATE, UNIVERSITY OF LONDON.
1933 GOLD MEDALIST, UNIVERSITY OF BOMBAY.
UNIVERSITY EXAMINER IN GEOLOGY AND GEOGRAPHY, UNIVERSITY TEACHER IN GEOGRAPHY 1935.
PROGRAMME OFFICER

AND

P. MARTIN-KAYE, R.A.F.

WITH AN INTRODUCTION

BY

D. N. WADIA

GEOLOGICAL ADVISER TO THE DEPARTMENT OF PLANNING AND DEVELOPMENT, NEW DELHI.

PART I: GEOLOGY
PART II: GEOGRAPHY

WITH MAPS, CHARTS, DIAGRAMS AND PHOTOGRAPHS

KARACHI
1946

DEDICATED

WITH KIND PERMISSION

TO

H. E. SIR FRANCIS MUDIE

K.C.S.I., K.C.I.E., O.B.E., I.C.S.

GOVERNOR OF SIND

INTRODUCTION

WHILE biology and the physical sciences have many votaries in India, who have produced worthwhile literature of interest and economic value to the people at large, geography and geology have, outside the official sphere, attracted in this country few scholars. These essentially field sciences demand painstaking application, field work and careful collection of accurate facts and data rather than laboratory research, but their study is of basic importance in any survey of the economic potentialities of a region. In the planning and economic development of a Province, its physiographical and geological features must form an essential preliminary ground-work.

Sind is fortunate in possessing in Dr. Pithawalla a devoted researcher in aspects of its physical, economic and human geography, its hydrography and agriculture. During the last 12 years, he has brought out a succession of monographs on these subjects, which will provide a solid background to future workers and to the builders of a New Sind.

In collaboration with Mr. P. Martin-Kaye of the R.A.F., who has produced a valuable contribution on the stratigraphy and structural geology of Karachi, Dr. Pithawalla has brought his work to a stage at which a fairly comprehensive monograph on the physiography of Sind has become possible. It will prove of great value to those engaged on the post-war planning and cultivation of the numerous economic resources, with which nature has endowed the basin of the lower Indus, lying between two prominent deserts.

Secretariat,
Department of
Planning and Development,
New Delhi

D. N. WADIA

FOREWORD

AFTER the War, reconstruction. The whole world is crying for it and we, who are living in an important city like Karachi, cannot lag behind. Again, in any scheme of reconstruction in a country, the physical basis cannot be neglected. Besides, Karachi is Sind and Sind is Karachi to a very great extent. In the planning and reconstruction of the whole province, the place of Karachi should be the first and foremost.

It is with a view to prepare a scientific study of the region of Karachi and its neighbourhood that the present work has been undertaken. But without the hearty co-operation of scholars, departmental officers and others, nothing substantial can be achieved in these days. Indeed, it has been my long-cherished desire to be serviceable to Karachi by preparing a scientific guide to the city and making a scientific approach to the solution of its many problems before any future planning can be done for its improvement, so that the advantages of Science may be properly synchronised with the fresh plans and maximum human happiness may be derived from them.

If the cruel World War has done any good to our country, it is the healthy contact of men from other parts of the world with us, and I wish to record herein the valuable service rendered by my young friend and collaborator, L.A.C. Peter Martin-Kaye, R.A.F., Korangi Creek, in this connection. He was in the final year of his course for the Bachelor's degree in Geology at the Imperial College of Science, London, before he was enrolled in the R.A.F. It is now nearly three years that he has been 'roaming' in India and Ceylon. Ever since he met me some six months ago, his desire was to make an intensive study of local geology. He has spared every moment of his leisure from his hard and exacting military duties, wandered about the places with a hammer and a clinometer from the Hab river to the Landhi hills for days on end and brought to me the valuable field data, which are now happily incorporated in Part I of the monograph on the geology of Karachi and its neighbourhood. Few students have come upto the level of self-sacrifice and devotion to Science in this respect as Mr. Martin-Kaye, under the circumstances, in which he has been placed. I have the highest respect for his ability and strength of character as a young Britisher. If builders of Greater Karachi are really interested in the scientific investigations, which must be made before any plans or

schemes for the future welfare of the city are undertaken, then this paper on local geology which we have produced, will, it is hoped, serve as a reliable basis. There must be in them a deficiency of understanding or of sympathy, if they fail to appreciate the value of such a regional survey as we have been able to make during the period.

Geography follows geology. There are many fields for geographers today to be serviceable to the world. Geography, as a young science, has to deal with the relationship between man and the earth, the earth below the surface and the atmosphere above it. Nearer home, it has to deal directly with town-planning, which involves the investigation of the sub-surface conditions of foundations, proper orientation of streets and buildings, water and drainage facilities, road alignments, suitable sites for reservoirs and the proper utilisation of the natural resources, products, minerals, etc. All this cannot be done without a thorough knowledge of local geography, which is included in Part II. In this way, some useful information about the existing conditions and the inherent potentialities of Karachi has been brought to light in a comprehensive manner. The rest is left to future and to fate.

Grateful thanks are due to Mr. D. N. Wadia, Geological Adviser to the Planning and Development Department, Government of India, for giving us an appreciative and encouraging Introduction. Prof. Wadia has been my guide and adviser for well-nigh two decades now. He has taken personal interest in all my researches. Had it not been for his encouragement in my work, I would not have been able to continue it so long.

Several other willing workers and officers have helped me in the collection of the material for this monograph and to all of them I extend my cordial thanks. I desire particularly to thank Prof. R. E. Mirza of the N. E. D. Engineering College and Mr. S. B. Kulkarni of the B. V. S. Parsi High School, who have helped me in the preparation of some of the maps and charts.

Lastly, my warm acknowledgment is due to the few patrons of learning in Karachi, but for whom this publication would not have seen the light of day.

Ketrat Building,
Victoria Road,
Karachi
1-2-1944

MANECK B. PITHAWALLA.

CONTENTS OF PART I

PAGE

PART I. GEOLOGY

PART I.—GEOLOGY

PRELIMINARY NOTE

The area, with which this work is mainly concerned, is bounded in the west by the Hab River on the Sind-Baluchistan border, in the south by the coastline of the Arabian Sea and in the north and the east by the hilly regions in the neighbourhood of two villages, Mangho Pir and Landhi respectively. Within this area of approximately two hundred square miles lies Karachi the most important city of Sind, the chief sea-port of N.W. India and the biggest airport of the country.

Tertiary rocks being particularly well exposed therein, a great deal of literature has been produced concerning the geology of the province and only a certain portion of this refers to the present area. These works, however, have either too large a scope to give more than the general features of the region, or, if they deal specifically with the neighbourhood of Karachi, they have done so only from certain aspects. A full list of the publications is given in the appended Bibliography, but some of the more important are mentioned here.

Officers of the Geological Survey of India have visited Karachi on several occasions. W. T. Blandford directed an investigation of western Sind from 1874 to 1877 and the results were published in 1879 in his "Geology of Western Sind". This admirable work still remains as the standard reference to this part of the province. In 1901, R. D. Oldham made observations on the sand-hills near Clifton, a suburb of Karachi. Mauripur salt works have been the subject of a note by the department and this appeared in 1924. Three years later and subsequent to a trial-bore for water at Drigh Road when traces of oil were noted, Dr. H. Crookshank reported favourably on the possibility of a neighbouring petroleum reservoir.

More general works include E. Vredenburg's "The Tertiary and Post Tertiary Fresh-water deposits of Sind and Baluchistan" (1909) and G. de Cotter's "The Alkaline Lakes and Soda Industry of Sind (1923)." This latter publication, however, scarcely deals with the Karachi area.

Additional works by the Geological Survey includes several editions of Palaeontologia Indica describing the many interesting fossils found within the province. These monographs also are enumerated in the Bibliography.

A thoroughly revised map of the area under investigation is yet to be published. The only decent geological map of Karachi and its neighbourhood is by F. Fedden, and, though old, it is still useful to us. E. Vredenburg also mapped a large area in Baluchistan and Sind on the scale of 1 inch equals 4 miles, but not of the Karachi area in particular.

Apart from the work of the Survey, comparatively little has been published. Captain N. Vicary's "Note on the geological structure of parts of Sind", written in 1847, was the first paper of any importance published on the subject. D'Archiac and Haine published their classic, "**Description des Animgux Fossiles du Groupe Nummulitique de l' Inde**", in the year 1855, and this has formed the basis of many subsequent palaeontological works. In more recent years, one of the present authors has published numerous papers on the geography of the Lower Indus Basin. Some of these papers refer to the geology of the Karachi area mainly with reference to the city's water supply, a problem which is reconsidered by him in the present study.

SECTION A:—PHYSIOGRAPHY

1. **General Features.**—The scenery of lower Sind has been developed under subtropical semi-arid conditions, although there are indications that the region possessed a damper climate in the past than at present. The aridity of the climate has resulted in the area, under investigation, having generally a barren and inhospitable appearance. Vegetation is poor and scanty except a few points, as at Malir, where the water-table in the valley almost approaches the surface and allows cultivation. The alluvial plains of the rivers Lyari and Malir, salty where the sea is near at hand, usually support only the growth of scrub and hummocks of coarse grass. Jutting from these plains, barren rocky outcrops form ridges and low hills. In the vicinity of the coast, salt flats, sea creeks and mangrove swamps are met with, especially in the east, where a great expanse of mud banks and sea inlets is found.

The annual rainfall is only about 8 inches. This usually falls within a few days of the year, consequently doing so fairly heavily. Unchecked by any natural vegetation, the rain-water is largely lost as run-off. Gulleying is prominent in the softer rocks and large quantities of sand and dust are swept away into the valleys.

The finer grained surface-deposits are continually subject to transportation by wind, which, with its load, is itself a potent factor of erosion. For a third of the year, this coast experiences winds of sufficient strength to raise a dust haze, and revolving 'dust devils' are a common sight. Sand dunes occur frequently but usually in the immediate vicinity of the shore. More evidence of the work of the wind is to be got in the exposed positions, where all the light material has been removed and an expanse of pebbles or rock fragments is found. These pebbles are often wind-polished, and faceted stones in the form of dreikanters are not infrequent. Exposed rock-surfaces may also be polished but are more often pitted and carved, the soft Manchar rocks being particularly susceptible to such an action.

2. **The Hills.**—The western border of upper Sind is skirted by the Kirthar Range, which lies north-and-south. The low hills of the Kohistan area are not continuous with the Kirthars but belong to the same system and may be considered as an outlying evidence of the same folding. Across the Baluchistan bor-

der are related members of the Pabb Range, which extends northwards to parallel the Kirthar Range.

Extending from Cape Monze (Ras Muari), which lies about 17 miles west of Karachi, to the Mangho Pir area, is a series of hills and ridges, sometimes known as the Jhil Range. Although largely in the form of a number of parallel ridges, the range possesses some summits above the general level. In the neighbourhood of the cape a hill of 460 ft. is found, but north-westwards summits of 772 ft., 776 ft. and 732 ft. occur. Of the named heights, Bol reaches 750 ft. and Haji Jara about 705 ft. Bearing away from the coast, the hills perform an S-bend, the village of Mangho Pir, about 10 miles north of the city, lying within the second curve. In this neighbourhood, three distinct ridges are discernible and are named Orangi, Ghora Lakki and Mangho Pir. The ridges are parallel and each rises sharply to within four and five hundred feet. Mangho Pir, the highest point, is 582 ft. above the sea level. The dip and scarp slopes are here well known, the former generally being preserved by a comparatively hard bed which often projects at the crest, slightly overhanging the escarpment. The lower slopes are covered with fallen debris, which merges into the rain-wash of the intervening valleys.

South-east of the city, a hill is located near the village of Ghizri. This marks the extremity of a series of low hills extending north-westwards and terminating to the north and slightly beyond Drigh Road. The Ghizri hill, which is 96 ft. high, is connected with the main series by a low rise, which passes near the Cantonment. The general elevation of the hills eastward does not exceed 200 ft. but some hill-tops exceed this height. Honeymoon Lodge, in the Cantonment area, is situated on a small hill belonging to the same outcrops, like those below the Parsee Tower of Silence close by.

E. S. E. of Karachi and beyond the Malir valley is situated a ridge which, on its far side, overlooks the creek and mud-banks area, extending to the Indus delta. In the neighbourhood of Ibrahim Haidari the ridge is approximately 100 ft. high and is bounded on both sides by abandoned sea cliffs. Inland, the cliffs soon fade out, but on the creek side they extend eastwards and beyond our present area of study.

3. The Valleys.—The river Hab, on the Sind-Baluchistan border, has formed the western boundary of the area. Where the

river is reached by the road from Karachi, it is found to be flowing through a broad alluvial plain, which lies in the valley between the Cape Monze range and the Baluchistan hills, that extend northwards into the Pabb Range. The present flood plain is below the level of the more extensive flanking alluvial deposits, in which river cliffs have been cut and numerous gulleys worn.

Of more importance to Karachi are the valleys of the Malir and the Lyari, as it is from the water-bearing alluvia of these rivers that the water supply of the city has been entirely obtained, prior to the Indus scheme. Unlike the Hab, these are not perennial rivers but only display a surface flow after heavy rains for a few days every year.

The Lyari alluvial plain lies to the north of the city and is here about five miles wide, although it is now an insignificant river, dry for most of the year. The valley widens into the delta region near the Keamari Harbour. The Malir empties itself into the Ghizri creek, after having passed down a wide valley between the Drigh Road hills and the Ibrahim Haidari-Landhi ridge. This valley supports a certain amount of vegetation, coarse grass and scrub near the sea, but inland, near Malir itself, good market-garden produce is grown.

The Malir alluvium has, for many years, provided almost the entire supply of water for Karachi from the wells at Dumlotte, while villages along the river course possess their own wells.

The denudation of the folded strata at Mangho Pir has produced a series of parallel narrow valleys, separated by the ridges. These are generally barren with a floor of hardened rainwash, cut by gullies and with additional debris fallen from the upper slopes.

4. **The planes of Marine Denudation.**—Distinct from the alluvial plains of the Malir and the Lyari are the planes of marine denudation, one occurring in the neighbourhood of Mauripur and the other, smaller and more recent, between Clifton and Bath Island. The former area has now been raised a few feet and offers further evidence of comparatively recent uplift of the land in this region. The Bath Island region has recently been abandoned by the sea and the highest tides only can encroach upon it to a certain distance.

5. **The Rivers.**—**The Hab river,** which possesses a perennial surface flow, drains the western side of the Kirthar. It plays

no part in the drainage of the immediate Karachi area owing to the intervening Jhil Hills. It has been considered, however, as a potential source of water for the city and it will be referred to again from this viewpoint. Its mouth, unlike those of the Lyari and the Malir, opens directly to the sea a few miles west of Cape Monze, the river having flowed through a broad alluvial plain in the latter stages of its journey. The presence of the river cliffs, which have already been noted, would seem to indicate a rejuvenation comparatively recently in its history. This is in accordance with other observations of terrestrial uplift. No tributaries of importance join this river within the area dealt with.

The River Lyari runs southwards for the major portion of its length, draining the eastern side of the Mangho Pir hills and their extension northwards. Turning southwest when close to Karachi, it terminates in the marshy flats west of the harbour area. It is in this fact that there lies one of the more important aspects of the river, in so far as these flats and creeks largely drain into the harbour works. During the few days of the year when a surface flow is displayed, large quantities of silt are discharged, some to be deposited eventually in the channel. The alluvium is water-bearing throughout the year and, before the Malir resources were developed, supplied the Old Town with drinking water.

The Orangi and the Guiro are the tributaries, which emerge from the Mangho Pir range and ultimately join the Lyari, close to Karachi. Whilst their main function is to remove run-off rain-waters, the former has perennial underground flow and at Orangi surface water is shown.

The flow of **the Malir** also is subterranean for the major part of the year in this region. The **Khadeji** and the **Mol**, by the confluence of which this river is formed, display surface waters, which are more or less perennial. Towards Karachi, however, the water-table passes much below the surface and, at Dumlotte, wells have been sunk to almost 60 ft. to tap the supply. The mouth of the Malir river is formed by Ghizri Creek, which joins with the Korangi Creek before entering the sea.

The elevation of Karachi being only a few feet above the sea, areas within the city itself are liable to be flooded during rainy periods, especially when they are accompanied by high tides. The low-lying Lyari quarter is always susceptible to

this and a low 'bund' has been erected along the Lyari bank to combat this problem. Roads, which cross the river beds, are often damaged by the flood waters of the normally dry streams. Those, which cross the Lyari to Mangho Pir and Mauripur and the Malir to Ibrahim Haidari and Landhi, are particularly affected in this manner.

6. Hot and Cold Springs.—The village of Mangho Pir has been built around a series of natural springs. Some of these are hot, and the water, which possesses medicinal properties, is utilised by the neighbouring Hiranand Leper Asylum and also by the general public, for whom baths have been erected.

The temperature of the hottest spring is 127 deg. F. but apparently varies. Lt. Carless visited the spot in 1838 and recorded a temperature of 133 deg. F. The water has a greenish tint and bubbles of gas can be seen coming to the surface at some points.

In addition to these hot springs, there are springs of cold water. Near the crocodile pool, the water is only luke-warm and "rushing from the rock underneath the tomb of Mangho Pir is a beautifully clear cold spring." A number of hot springs are to be found further north in the Kirthar Range, so that altogether there are about twentyfour within the province. No other spring, however, is as hot as the one at Mangho Pir.

In 1924, a borehole was sunk to the depth of 873 ft. near Drigh Road. Although subsequently it was filled up, hot water still issues from the casing.

A cold water spring also occurs at Waghodhar near Landhi.

Thus the presence of these surface springs, many feet above the sea level, is remarkable in an otherwise arid region.

7. The Coast.—The sea is completely shallow close to the harbour, the five-fathom line being about four miles distant.

From the mouth of the River Hab, the coastline projects south-westwards, into the Arabian Sea, to form Cape Monze. It then extends eastwards, firstly with low cliffs, 40 ft. to 50 ft. high, to be followed by a low shore-line as far as Manora Islands. This island is connected to the mainland by a low sandy neck of land and thus forms the western side of the Keamari harbour entrance. Trending from thence south-eastwards, the shore continues low and becomes punctuated with the creek outlets, when the creek region is reached.

Cliffs occur at Cape Monze, but as the hill range passes inland, these disappear. Even at Hawkes Bay, however, which lies half-way between Karachi and the Cape, a low cliff, only a few feet high, separates the sea from the inland plain. Manora Island stands out sharply and measures have been taken to protect its cliffs. Abandoned cliffs, now lying away from the sea are to be seen at Clifton, near Ghizri and near Ibrahim Haidari. Shallow caves occur at Manora, Clifton and other places.

Sand-hills are to be found at various points throughout the area but are prominent in the immediate vicinity of the shore line. Both the Burkhan and the elongated 'whale-back' dunes are present, but continually altering in shape, size and position according to the season. They are prominent to the south-east of Clifton. Dunes also occur in the creek region and some have been naturally anchored by grasses. Isolated sand-hills can be observed in the lower Malir valley and at many points along the coast. The origin of this wind-blown material and the growth of the sand-hills is referred to later in this Part, when superficial deposits generally are considered. The hills sometimes rise to a height of 30 ft. but usually less. The Burkhan dunes have one limb longer than the other and composite types are occasionally to be noted. Distinct from these crescentic types are the 'whale-back' sand-hills, elongated in the direction of the prevailing wind. In this region the south-west Monsoon, being the strongest and most constant of the annual winds, has the greatest influence in the transportation and deposition of sand and dust. With the alteration of the seasons, however, many of the sand-dunes alter their shape and direction. According to the strength and direction of the wind, old ones are removed and new ones appear. All but the dunes, anchored by vegetation, move leeward, but the areas, subject to deposition of wind-borne material, remain fairly constant.

8. **The Creek Regions:**—East-south-east of Karachi lies a vast expanse of mud-flats, sandbanks and mangrove swamps, intersected by a complicated system of ramifying creeks and inlets. This system merges into the Indus delta and covers about a thousand square miles before the Ochito outlet of the river is reached.

Of the more important of these creeks, the Ghizri has already been mentioned as the outlet of the Malir. Prior to the construction of Kiamari harbour, about a century ago, this inlet

was actually utilised as an anchorage by coastal craft. Owing to silting it has now fallen into disuse for this purpose. Korangi creek, with which it joins before crossing a sand-bar to the sea, has come into prominence since the R. A. F. started making use of it, and is still used as an anchoring place, while the village of Ibrahim Haidari is quite important for fishing and trading. The inlet continues for several miles in a north-easterly and then an easterly direction, finally ending in the Bakran region (approximately Lat. 24 deg. 47 mt. N., Long. 67 deg. 20 mt. E.). Numerous waterways lead from it or into it viz. Ghizri, Gangiara, Kadiro, Khanano and Bakran. Jhari Creek lies parallel to the Korangi and reaches the sea via the Pitai mouth. All the seaward entrances to the creek system possess a sand-bar and although ten to twenty or more feet of water may be found inside, the depth over these bars is usually not more than a fathom at low-water spring tides. The ten-foot maximum tidal range produces strong currents, which tend to keep the channels of the creeks clear.

9. **The Islands:**—Churna Island lies to the west of Cape Monze and opposite the mouth of the Hab. At its highest point it rises to 580 ft.

Manora Island forms the western side of the entrance to the mainland by a low sandy stretch of land. Baba Island, though much smaller, lies close by and is also included in the harbour-works. The Manora breakwaters project seawards from the island and protect the entrance from the swell raised during the S. W. Monsoon. The Kiamari island was originally separated from the mainland. The connecting Napier Mole was completed in 1850. Thus by the utilisation of these islands, Manora on the western and Kiamari on the eastern side, the semi-natural harbour has developed.

North-east of the Manora point are some small rocky islets more in the form of sea stacks and needles than islands. They are called Oyster rocks; Bara Andai, the largest, rises abruptly to 86 ft., Baur Island is slightly smaller and Pyramid Rock with Chota Andai lies close by.

Bath Island is now only so in name, having been abandoned by the sea recently.

Kanjar Island, east of the Korangi-Ghizri mouth, forms the first of a great number of similar sandy banks in the creek region.

Even Clifton must have been an island not long ago and before the alluviation of the surrounding plains and the recession of the sea.

Thus the old town of Karachi, situated near the coast, was surrounded in the past by several islands, cut up from the mainland by the denundation and erosion of its soft rocks by the agency of a powerful sea, infuriated year by year by the monsoon winds.

SECTION B:—GEOLOGICAL FORMATIONS

General Observations.

Cretaceous rocks are the oldest to outcrop in Sind. They cover a comparatively small area, however, in the Laki Range, and the bulk of the exposed strata of the province is of Tertiary age. Within the area under survey, only the Middle and Upper Tertiaries are represented. Nari beds of the Oligocene system form the lowermost outcrops. These are overlain by Miocene rocks, the Gaj series of lower Miocene and the lower Manchar series of Upper Miocene age. The Upper Manchars are included in the Pliocene system, which could develop further in the Makran series beyond the Hab and not in Sind. Quarternary deposits are represented by an extensive conglomerate, which unconformably overlies the Manchar rocks and slightly overlaps on to the Gaj series. Of comparatively recent origin are the alluvial sands and gravels, wind-blown material and other shoreline deposits.

The lower Nari and the Gaj rocks were laid down mainly under marine conditions, but the Manchar sandstones are indicative of an ensuing changing estuarine and fluviatile period, perhaps of a delta region. The Post-Tertiary conglomerate was probably formed by flood waters from the north during the Pleistocene period.

The rocks are well exposed in dissected folds. This folding is comparatively mild within the area, becoming most pronounced in the north and the west. Dislocation due to faulting is only slight and the structure of the area is not difficult to decipher.

On the whole, the geology of the Karachi area is unique and representative of the whole of Sind, which affords, in its turn, in Blanford's words, "by far the best epitome of Tertiary Geology hitherto observed in India." (See Plate I: Geological Map and Section).

A summary of the rock relations is given in the accompanying Table:

TABLE SHOWING

Post-Tertiary and Tertiary Formations Near Karachi

Geological System	Stage	Earth Movements	Formations in Lower Sind	Occurrence in the Karachi Area	Nature of Deposits	Conditions of Deposition	Probable Depth and Age
Recent			Superficial deposits	Widely spread	Aeolian, littoral sands, silts, muds or gravels	Subaerial erosion and deposition under semi-arid conditions. Littoral	Superficial only
Pleistocene			Superficial deposits	Cape Monze, Hawkes Bay, Clifton, Ibrahim Haidari, etc.	Raised beach and raised shell-banks, older alluvium	and deltaic, moister climate than at present	From the present time to 400,000 years
		4th Himalayan upheaval	Post-Tertiary conglomerates	Areas East of Karachi, Ibrahim Haidari, Manora, Clifton, Oyster Islands, Mauripur, Hab Valley, etc.	Coarse conglomerates and grits	Fluviatile origin	6 ft. to 12 ft. 500,000 years.
Pliocene	Villefranchian					Partial denudation	
	Astian						
	Plaisancian	3rd Himalayan upheaval	U. Manchar	E. and N.E. of Karachi skirting E. of Mangho Pir	Sandstones, clays, marls, occasional conglomerates	Warm climate cooling in the upper stages. Fluviatile estuarine, and	

	Pontian		U. Manchar	Hills S.E. of Ghizri, Clifton, Manora Islands, Oyster Rocks.	and concretionary beds mainly unfossiliferous, but	deltaic conditions with minor marine transgressions	100 ft. to 200 ft. 750,000 years.
	Sarmatian		L. Manchar	Ibrahim Haidari, Landhi, Mauripur, Hawkes Bay	with some fossiliferous marine bands		
	U. Tortonian		L. Manchar	As above	Sandstones and marls		
	L. Tortonian		L. Manchar	As above			
Miocene	Helvetian	2nd Himalayan upheaval	L. Manchar	As above			
	Burdigalian		U. Gaj	Cape Monze Mangho Pir Hills, Ghizri, Drigh Road Dome	Sandstones, fossiliferous limestones	Warm shallow sea	1000 ft. to 1500 ft. 10,000,000 yrs.
	Acqutanian		L. Gaj	Large areas E. and N.E. of Manchar outcrops	Clays and Coral beds		
	Chattian		U. Nari	Hab Valley, Cape Monze Hills, Mangho Pir	Sandstones and limestones	Marine deposits in	4000 ft. to 5000 ft.
Oligocene	Stampian		U. Nari	As above		Nari Sea	100 ft to 1500 ft
	Lattoffian		L. Nari	As above			20,000,000 yrs.
Eocene (not found in the Karachi area)		1st Himalayan upheaval	Kirthar Ranikot Deccan Trap	Laki Range	Nummulitic limestones, Nummulites, Decomposed trap		5000 ft. 2000 ft. 40 ft. to 90 ft. 50,000,000 yrs.

OUTCROPS WITHIN OUR AREA.

1. **The Nari Series.**—The Nari beds in the neighbourhood of Karachi are overlain by a blanket of Manchar and Gaj deposits. They are exposed, however, in the core of the dissected folds at Mangho Pir and also partially form the ridge of hills that extends from this area to Cape Monze. The mass of the rocks is formed by sandstones with interbedded shales and limestones. Some of the limestone bands are fossiliferous and near the top of the series, there is a fairly persistent bed containing foraminifera, especially **orbitoides sp. pectens,** and the **echinoid clypeaster** are also fairly common.

Towards Karachi, the Nari beds dip under the Gaj. They are supposed to have been met in a bore near Drigh Road, where comparatively well developed sandstones occur near the bottom. The reasons for supposing these to belong the Nari are quoted below, under the reference to the Drigh Road Gaj beds.

Local Details.

(1) **Mangho Pir Area.**—Nari rocks are exposed in the core of a denuded anticline here. To the S.W. of the village and to the west of a low ridge occurring near the Hindu Rest House, they outcrop from beneath the Gaj series. The Nari-Gaj junction is unfortunately obscured by alluvium, rainwash etc. in the valley immediately beyond the ridge. Lying about half a mile distant, the first main outcrop forms a larger ridge, beyond which is the hill of Mangho Pir itself (582 ft. high). This first ridge includes the foraminiferal band already mentioned. Underlying this area there is a series of generally dark-coloured sandstones, shales, and further limestones. This particular ridge runs approximately N.N.E. before fading out with dips of about 25 deg. E.S.E. The Gaj-Nari junction, however, lies in a practically north-south line to the north of this position. To the south it wings round to the west and then north again, so that the width of the Nari outcrop here is about two miles but broadens northward, as the junction swings round again to follow the Cape-Monze hills to the sea.

Dips upto 50 deg. are found at the bottom of the hill-path to the summit of Mangho Pir, but there has apparently been minor faulting here and the outcrops appear to be striking at various angles in response to the supplementary compression,

which has been applied approximately at right angles to the main folding (See Section D: Tectonics).

(2) Cape Monze and River Hab Areas.—By taking the Hab road from Mauripur, the Gaj-Nari junction is crossed in the low range of hills that lead from Cape Monze to the west of Mangho Pir. The highest portions of the range are formed by Gaj beds, the Nari series outcropping in a series of long and low ridges that are found in the Hab Valley itself. Here they occur largely as brown sandstones but some white sandstones occur outcropping by the roadside, stained red and pink in patches. The Hab building stone, obtained from this region, has a pinkish colour. A little further towards the south-west a prominent fault crosses the boundary between Gaj and Nari rocks.

Near Haji Ziar (Ziar Pir) hill and again close to the top of the Nari group, there occurs a hard limestone bed with orbitoides and other foraminifera, presumably continuous with that of the Mangho Pir outcrop.

At the Cape, the Nari rocks again form the core of an anticline and the Gaj rocks re-occur on the western side of the outcrop and continue to the mouth of the Hab.

2. The Gaj Series.—The lower Miocene rocks, that form the Gaj series, are well exposed near Karachi, a portion of the city actually having been built upon them. Many houses and public buildings are constructed of local Gaj stone, which is well suited for this purpose. The buff-coloured limestones, that are so utilised, also serve for the provision of road metal. In addition to the limestones, however, sandstones and clays are well developed.

The rocks are of marine origin and some horizons, especially in the limestones, are highly fossiliferous.

During the period of deposition, the Karachi area with much of Sind was occupied by a shallow gulf of the sea.

An indication of the conditions, then existing, is given by the presence of coral beds. Present-day reef-building corals require a sea temperature of not less than 20 deg. C and do not live below a depth of about twenty fathoms. It may be assumed that the Miocene sea of Karachi area conformed with these conditions. At some periods, the depth must have been a matter of a few feet, as current-bedded sandstones are met with. Occassionally the sea became muddy and calm and clay beds resulted.

Outcrops occur to the south-east and east of the town, forming the low hills which commence near Ghizri, underlie a part of the Cantonment and extend to the north of and slightly beyond Drigh Road. The beds are brought to the surface in an elongated dome. They dip under the town and reappear in the denuded anticline of the Mangho Pir region. Towards Mauripur the fold pitches sharply, causing the Gaj ridges to swing in a semicircle. Further towards the Hab, the outcrops bear seawards again and reach the coast at Cape Monze, where they are folded into a further anticline.

Local Details.

(1) **Ghizri.**—The Ghizri hill is formed of Gaj rocks of the south-western extremity of the elongated dome. The hill is extensively worked for building stone and road metal in a series of shallow, open quarries. The surface limestones are utilised and quarrying downward is checked by the passage of the beds into sandstones and subsoil water.

Informative sections may be seen at points along the abandoned sea-cliffs that skirt the hill on its eastern side. The sections, represented in Plate III figs 1 to 4, are to be found along these low cliffs, the positions having been marked on the sketch map. The first section is taken from an exposure on the western side and near the top of a dry stream gully, that originates close to the Indian Military Hospital. Here a buff-coloured limestone, containing fossil fragments, rests upon sandstones. Similar series are shown in the cliffs beyond the end of the gulley and where the cliff face is not covered by talus. Some of the sandstones are false-bedded and more argillaceous intercalations are quite frequent.

Dips are low and do not usually exceed 5 deg. Beyond the summit of the Ghizri hill, the beds dip S.E.E. and eventually pass beneath a narrow isolated ridge of Manchar rocks. The junction of the two groups is, unfortunately, obscured beneath superficial deposits, which have collected in the shallow depression between the hill and the ridge.

(2) **The Cantonment.**—The British Military Hospital is partially built upon Gaj limestones. A few sections of the strata may be observed in the neighbouring cuttings of the N.W. Railway, where a low westerly dip is shown. Here again the limestone bed is resting upon sandstones and sandy marls, represented in fig. 4.

The local landmark, Honeymoon Lodge, stands on a Gaj hill, the sides of which are littered with fallen blocks from the capping bed. Following the Ibrahim Haidari road for a short distance beyond the hill, the beds may be seen passing below the superficial deposits of the Malir valley at an angle of 4 deg. From the road, the outcrops can be traced towards Ghizri Hill. Towards Drigh Road, a quarried ridge gradually gains in height. Current-bedded sandstone and an irregular blue-grey marl with concretions can be observed in cuttings by the Drigh Road itself.

(3) **Drigh Road and Malir.**—The most complete series obtainable of the Gaj of the Drigh Road region is given in the bore which was sunk in 1924 near the 6th milestone of the road from Karachi. A depth of 873 ft. was reached before the operations, which were concerned with an attempt to tap an artesian water supply, were abandoned. A similar shaft was sunk in 1940 near the confluence of the Malir and Bazar Rivers, about 18 miles from the city. The project was undertaken by the Karachi Municipal Corporation at the instance of one of us, (Vide Mr. Bhide's Note No. 4 on Karachi Water Works), for the same purpose, but, as before, the results were not regarded by the Municipal Corporation as sufficiently encouraging and both bores are now sealed up. It is interesting, however, to compare the strata penetrated and these are represented in Plate V, figs. 1 & 2. Although both the bores pass through Gaj beds, there are considerable differences in the development of the rock types. Thus, about 250 ft. of limestone occur over a dozen horizons at Drigh Road, to less than 50 ft. of it only in three horizons in the Bazar boring, where sands and sandstones form greater thicknesses. Clays and shales are more equally developed. However, more fresh water flowed from the latter bore-hole than the former one. Under conditions of comparatively shallow water depositions, such variations are to be expected.

During the course of the earlier operation, a smell of oil was noticed and later on, an oily scum was seen on the surface of the brine issuing from the well. In consequence of these observations, Dr. H. Crookshank of the Geological Survey of India, made an examination of the area to ascertain the possibilities of the occurrence of a neighbouring subterranean oil reservoir. He reported favourably on the prospects and suggested the most likely point towards the apex of the hill "253" for a successful bore. In doing so, Crookshank estimated the position of the Gaj-Nari junction to lie about six feet below the petro-

liferous sandstone, that is, 821 ft. below ground level. In favour of this he remarks: "The sandstone at the bottom of the borehole is at least 52 ft. in thickness, and may be much more. As it contains water at high pressure and in great quantities, it is probably a widespread formation and no mere sandy lenticle. But the only important lower Tertiary sandstone in other parts of Sind belongs to the upper Nari group. Consequently the lower part of the bore has probably pierced the upper Nari rock." If this is correct, it seems probable that the Malir-Bazar boring did not reach the junction, in so far as:—

(a) It was only taken to a depth of 800 ft. The junction of the Gaj and Nari is regarded as lying at 821 ft. at Drigh Road;

(b) Since the overlying Manchar rocks are pierced, the Upper Gaj beds have remained unaffected by the post-Manchar denudation, to which those exposed at Drigh Road have been subjected and consequently a greater thickness would remain.

(4) **Mangho Pir.**—North of Karachi, Gaj rocks occur in the region of low hills and ridges, in which the village of Mangho Pir is situated. Skirting the exposed Nari core of the anticline, outcrops extend north-eastwards on the Lyari side. The western exposures extend north only for a short distance before turning towards Cape Monze. Both the flanks of the anticline join in the south and the beds dip outwards, to pass beneath the cover of Manchar and superficial deposits. On the Lyari side, however, the alluvium is outflanked in the north and the Gaj outcrop becomes wide.

Taking the Mangho Pir road from Karachi, the Lyari alluvium and the concealed Manchar beds are crossed. About six miles from the city the first of the ridges of the Mangho Pir range rise sharply out of the plain. This ridge rises to about 250 ft. at the crest, but the road passes through a gap cut perpendicularly, beside the Orangi Nadi. Although the stream bed is usually dry for the remainder of its course to the Lyari, fresh water is found above the surface here.

The first outcrops are seen by the roadside before the gap is reached. Here buff-coloured limestone dips E.N.E. at 15 deg. but this dip increases at the main outcrop. Southwards of this point, dips up to 50 deg. occur. Interbedded with the limestones are sandstones and minor clay beds. Beyond the Nadi, a fossiliferous limestone occurs in which echinoid fragments have

been observed. Continuing along the road to the 7th milestone, the next ridge (Ghora Lakhi) is skirted. It rises sharply on the right hand side, with the road near the base of the escarpment. A durable capping layer, a tough limestone, stands out strikingly along the crest of the escarpment. This is slightly fossiliferous and contains a few shell fragments. Seen in the strike direction, the beds appear horizontal, the apparent dip being zero. About half a mile further on and on the left-hand side of the road, with which it runs parallel, is a comparatively low outcrop of a coarse grit and lying beyond this is found the dip slope of a further ridge. Here the uppermost beds are full of corals, forming an almost continuous layer for some distance. Underlying the coral bed is a series of grey sandstones. A further coral bed, remarks Blanford, "can be traced at the base of the Gaj rocks for some distance round the curve of S.W. of Mugger Peer but this dies out and is not met with again to the south-west." This bed can be seen in small exposures near the Mangho Pir crocodile pool. The junction of the Gaj with the Nari lies close to the west of the village, but, as has been noted before, it is obscured by alluvium.

The Gaj beds are also crossed, south of this area, by the road to the Hab river. The first outcrop occurs very close to the bifurcation of the Mauripur and Hab roads. Here typical limestones occur some 300 yards from the junction dipping about 15 deg. E.S.E. These are displayed only for a short distance, however, and no further outcrops occur until the base of the Hab hills are reached. Here the Gaj beds form a well-marked ridge, which continues to Cape Monze, reaching 776 ft. at one point. The Gaj-Nari junction is generally not noticeable, as usual due to the growth of superficial deposits.

(5) **Beyond Mangho Pir**—A trip from Mangho Pir to Bund Murad Khan, in the Hab valley higher up, is also instructive from the point of view of Gaj-Nari formations. e.g., the W.S.W. dip of the hill, the fault crossing the Gaj and Nari rocks at and near Lehra, the coral beds starting from Bund Murad Khan and extending for many miles southwards and the Manchar-Gaj groups interstratified and composed of arenaceous sandstones and argillaceous conglomerate overlying the Gaj marine beds, all dipping at very low angles.

The banks of the river, across which the road to Las Bela State lies, are overstrewn with numerous pebbles, derived from the conglomerate.

3. The Manchar Series.—The Manchar rocks surround and partially underlie Karachi. They are largely unfossiliferous sandstones, although marine bands with shell and bone fragments occur. Associated with the sandstones are marl beds, which are sometimes gypseous. Conglomerates occur, but these are generally not well developed. Persistently overlying the group, however, is an extensive conglomerate, which, being rather durable compared with the soft sandstones and marls below it, acts as a protecting layer for the Manchars but belongs to a later age.

The sandstones display rapid variation both laterally and vertically. Although brown micaceous sandstones form a large proportion of many of the exposures, other types, sometimes rather peculiar, are usually shown. Concretions are to be found in some of the beds, and are usually argillaceous calcitic geodes. Even in the more regular sandstone layers, nodules are frequent. These are formed by the aggregation of calcareous cementing material. The calcareous sandstone, being more durable than the mass of the mainly non-calcareous bed, eventually projects as a series of nodules from the face of the exposure. The nodules are usually not large, being in the form of a flattened sphere about nine inches across, on an average. Some are elongated but regular in shape.

Percolating iron-bearing waters have turned some of the calcareous sandstones ferrugeneous, but they are not so highly oxidised as to produce ferric oxides or limonite, due to the arid climate.

Gypsum occurs near Landhi, interlaminated with marls. The individual lenticles are usually less than half an inch in thickness and composed of colourless, sometimes fibrous, gypsum.

The marine beds are easily identifiable, being for the most part durable, and consequently they form projecting beds, shelves, etc. They vary in composition but are generally not more than two feet in thickness. At some localities the bands are composed almost entirely of shell fragments. Bone fragments and pieces of fossilised wood are not uncommon.

The variations, displayed by the strata, are indicative of fluviatile conditions of deposition with minor marine invasions to form the fossil bands. Many of the beds are current-bedded and at one or two localities ripple-marking may be noted. Deposi-

tion of the group commenced in the Upper Miocene, the Gaj beds having been subjected to mild folding in this area, and terminated in the Middle Pliocene. Further folding occurred and the Manchars were affected.

LOCAL DETAILS

(1) **West of Karachi.**—Manchar beds occur up to the Gaj hills that extend to Cape Monze. On the Mauripur roads, the old and the new, and in the immediate trans-Lyari region, a low ridge of Manchar rocks is found. These are capped by the Post-Tertiary conglomerate. The ridge extends north-eastwards to flank the Mangho Pir Hills and where it is cut by the Karachi-Mauripur and R. Hab road, the strata dip at 22 deg. in a S.E. direction, passing under the Lyari alluvium. Here, the group is represented by thinly bedded micaceous sandstones, there being no signs of the marine beds found in other regions. Gaj limestones appear a few yards westwards but the junction is obscured.

(2) **North of Karachi.**—Following the Manchars north-eastwards, they pass beneath the alluvium which overlaps the Gaj. Exposures occur in gullies, however, and the beds may conveniently be seen in the course of the Orangi Nadi. As the alluvium decreases beyond this point, the outcrop broadens into a wide expanse.

(3) **The Cantonment.**—In Karachi itself, the conglomerate can be observed on the south side of Bunder Road Extension near the Amil Colony. It is possible that this covers some Manchar rocks, although Gaj limestones outcrop close by. On the other hand, as Blanford mentions, there is an overlap by the conglomerate on to the Gaj and perhaps this is another instance.

(4) **Bath Island and Clifton.**—On the southern outskirts of the Cantonment, on the right-hand side of the Clifton road, is a low hill known as Bath island. Although now misnamed, it was undoubtedly separated from the mainland upto a comparatively recent date. The 'Island' rises to about 30 ft. and is covered by pebbles loosened from the conglomerate below. This conglomerate covers Manchar rocks, seen in sections round the hill, in a manner similar to its occurrence at Clifton, about half a mile to the south. Caving is noticed around the hill, though the sea is now some distance away.

The low hill, upon which Clifton is built, was also an island until recently. On the seaward side, there are abandoned sea-cliffs and caves of finely laminated Manchar rocks, extremely weathered in the Temple in places, in which pigeons have found their holes. It is an excellent example of differential denudation. The present shore-line is now about a quarter of a mile distant. On the inland side, there is a plane of marine denudation that separates Bath Island and the Cantonment. In the cliffs some of the Manchar rocks of the area are typically displayed. Beneath the Post-Tertiary conglomerate, brown and gray sandstones with some thin interbedded marly layers may be noted. The beds are inclined northwards at about 5 deg. Even at Old Clifton the exposures of the Manchars, with the top cover of conglomerate are similar. Here are some of the sections of extremely fine laminations in the soft sandstones underlying the hard strata.

(5) Near Ghizri.—Further outcrops of the Manchars occur to the west and to the south-east of Ghizri. The latter locality has been mentioned in so far as the Gaj limestones dip below the younger beds at this point. The outcrop is in the form of a narrow flat-topped ridge which is about 90 feet high, and lies in a N.E.-S.W. direction, and, although it is about a mile long, it is often only 100 yards in width. The capping Post-Tertiary conglomerate here again is present. This and the underlying beds are diagrammatically represented in two of the accompanying vertical sections (Plate III, Sections 1 to 9). A marine band largely composed of shell fragments but also containing a few small pieces of bone, projects as a shelf for some yards further than the S.W. end of the main ridge. Whereas the overlying conglomerate is practically horizontal, the apparent dip of this calcareous bed is 3 deg. or 4 deg. N.E., thus causing it to descend to the base of the seaward cliff face, as we trace it in this direction. It then passes beneath the surface with the result that it is not shown in the second vertical section, which was taken from beyond this point.

The junction with the Gaj rocks is obscured as usual by superficial deposits.

(6) Oyster Rocks.—Lying off the coast of Clifton and about a mile east of the harbour entrance are the rocky islets of Chota and Bara Andai, Pyramid Rock and Baur Island, collectively known as Oyster Rocks. They are of Manchar sandstones,

which are capped by the usual conglomerate. The dip of the beds is apparently north at a very low angle.

(7) Manora Island.—This island has been included in the harbour-works to form the west side of the entrance. Its comparatively soft Manchar rocks have been reinforced in places by a concrete facing as a protection against the monsoon waves. The usual conglomerate overlies the Manchar sandstones and arenaceous clays, which dip at a slight angle in the N.W. direction. Shallow caves have been cut at the base of the cliffs on the seaward side of the island.

(8) Near Ibrahim Haidari.—Some of the best Manchar exposures of the region may be seen along the ridge that lies about seven miles from Karachi Cantonment on the opposite side of the Malir alluvial plain. On the Malir river side, this flat-topped ridge rises abruptly from the plain in talus-covered cliffs, which have evidently not been long abandoned by the sea. The cliffs extend north-eastwards from the Ghizri Creek termination of the ridge, cut at intervals by gullies. They then veer towards the small settlement of Bambo Khan Karmati, where they become lower and the rocks pass under the alluvium. These rocks continue north-eastwards in a slightly elevated area but without cliffs on this side.

On the further side of the ridge, overlooking Korangi Creek, cliffs are also found, except at the south-western end, where the beds slope gently towards the creek and pass beneath its waters. The top of the ridge is at a fairly constant elevation of about 100 ft.

In gullies and in places where the cliff's face is not obscured by scree, some good exposures of Manchar rocks may be found. The series, displayed at some of these exposures, are represented in the vertical sections (See Plate IV, Sections 10 to 22). The numbers refer to the positions noted on the sketch map. As may be seen from them, the sandstones, which predominate, display some variety, micaceous, argillaceous and more rarely concretionary, massive, false or thinly bedded.

Commencing an examination of the ridge from its south-western termination and continuing along the cliffs overlooking the Malir plain, the following points can be noted. There are two distinct marine bands, gasteropods being particularly prominent in the lower one, from which bone fragments and pieces of

fossilised wood were also obtained. These bands are similar to that occurring near Ghizri and also stand as projecting beds. The overlying conglomerate is unconformable and although this rock, forming the top of the cliffs, remains at a constant height, the fossil beds dip below the surface and are not seen again, until the outcrop, from which Section 9 was taken, is reached. Here one of the marine beds, apparently the lower one, forms a low ridge in front of the main escarpment. Fossiliferous beds again occur in the region of Section 12, where the trend of the cliff face veers towards Bamboo Khan Karmati.

Grey and pinkish marls occur near the base of some of the sections. They may be first observed in a gulley in the neighbourhood of the Rifle Range near the end of the ridge and may be seen lower down in some of the exposures, further north-east.

(9) **Near Bambo Khan Karmati.**—Towards the Ghizri creek the dip is about 4 deg. S.E. but is in the reverse direction near Bambo Khan Karmati. The Manchar rocks have been elevated in a low anticline, which has been partially removed by marine erosion on its north-western side in the past, leaving a vestige in the small outlying hill and the fading cliffs of the main ridge that occur near this village (See Section 20).

(10) **Near Landhi.**—Between Ibrahim Haidari and the region of Landhi, some low cliffs expose the eastward continuation of the Manchar rocks. As we proceed along these exposures, the marls become more prominent and are quite well developed near Landhi and Goth Rehri, where they become gypseous. The conglomerate is absent here, having faded out between the two villages. Several good exposures in the marl occur in the gullies which lead into the creek. The bed overlies a hard nodular sandy clay with occasional ferruginous inclusions. A water tower stands near the cliff edge and here a sandy bed with fossil fragments is associated with typical Manchar sandstones.

In the outcrops immediately beyond the tower, pink and grey marls again become prominent, these being intersected at intervals by gullies, in which good sections are displayed. Gypsum occurs especially near the top of the creek cliffs but only in thin lenticles as before. Towards the village of Rehri, typical brown Manchar sandstones replace the marls and form vertical cliffs in contrast with the sloping rubble-covered sides of the outcrops of the latter.

About half-way between the promontory, on which the water tower stands, and the village, small deposits of dark grey and black lignite are at present mined. This bed is, as far as has been discovered, is only local but may or may not extend inland from the cliff, where the shafts, which penetrate only a short distance horizontally, are situated.

More gypsum can be observed in the exposure at the brackish water well close by. This differs from the previously mentioned deposits of the mineral, as it occurs in the amorphous form, although very impure. Soft fossiliferous sandstones can also be noted here, oyster shells being most common. Fragments of shells may be occasionally seen in the beds associated with the coal.

The wide gulley, which contains the track leading to Goth Rehri, marks the eastward limit to which investigation was carried.

4. POST-TERTIARY DEPOSITS

Extensive areas of Post-Tertiary deposits occur in the neighbourhood of Karachi. They include:—

(1) Pleistocene : Conglomerates and grits.

(2) Sub-recent : Raised beaches, shell banks and old alluvium.

(3) Recent : Wind deposited dusts and sands, creek muds and silts, beach material, new alluvium and rainwash, sand-hills.

As they are widespread and not restricted, except a few, to any particular localities, they are here treated differently.

(1) Pleistocene: Conglomerates and Grits.—Lying uncomfortably upon the comparatively soft sandstones and marls of the Manchar series and protecting them from erosion is a remarkably persistant conglomerate. This and similar conglomerates occur, not only in the Karachi area but also in parts of Upper as well as Lower Sind.

In the present locality, the rock forms a tough and resistant bed composed of pebbles, mainly derived from the older series and well cemented with an arenaceous matrix. This matrix varies from a tough sandstone to a coarse grit, the bed in some places being entirely of the latter without any pebbles. Usually,

however, pebbles from the Gaj and Nari series are contained in great numbers and reach a size of 8 or 9 inches on the long axis. Many of them are fossiliferous and pebbles of coral or foraminiferal limestone are common. Occasionally the conglomerate itself is fossiliferous and Blanford mentions that fragments of shells and bones were noted in it on Oyster Rocks. Near Ibrahim Haidari, lenticles of sandstone, occurring in the coarse grit that represents the bed, contain oyster shells.

The bed occurs at most of the Manchar exposures that have been referred to viz., Manora where it is well shown in the cliffs, Oyster Rocks, S.E. of Ghizri, Clifton, Ibrahim Haidari, Bambo Khan Karmati, Bath I., the Mauripur Road and in gullies near the Orangi. In addition, it occurs in the area between the Amil Colony and St. Philomena's School in the neighbourhood of Bunder Road Extension. East of the town, as Blanford remarks "on the Sehvan Hill road, the Manchar beds come in but they are, as usual, concealed by an immense spread of Post-Tertiary Conglomerate". A similar rock occurs at points in the bed of the Hab River.

In thickness, the conglomerate varies from about one to twelve feet, although it is most commonly found between two and six feet. Current bedding is sometimes displayed in it as at Clifton and Ibrahim Haidari. Some areas seem to have weathered comparatively easily, leaving the pebbles as surface gravel. Greater differential denudation of the underlying soft sandstones and clay results in the collapse of the conglomerate, which gets usually removed thereby. This bed is missing entirely from the cliffs over-looking the creeks in the neighbourhood of Landhi for the same reasons.

The unconformity of the bed with the Manchars is visible at several points including Clifton, Ibrahim Haidari and in the gullies near Orangi.

(2) Sub-recent: These are divided into two classes: (a) Raised Beach Deposits.—Abundant evidence that the land now above the sea level, was submerged comparatively recently, is found in the form of raised beach deposits, mainly as raised shell banks. No continuous raised beach at any one level has been noted, however, the deposits being more or less continuous, where preserved, from about 100 feet to the present sea level.

Raised shell banks or fragments of shells have been noted at Hawkes Bay, Clifton and Ibrahim Haidari. At the S.W. end of the ridge at the last named locality, shells are found in quite considerable numbers upon the highest point of 92 feet.

Where this ridge bears N.N.W., oyster shells may be found attached to fallen blocks of the conglomerate. These are about 10 ft. to 15 ft. above sea level. The Malir alluvial plain of this region contains occasional scattered shells. Oyster-shell banks, a few feet above the present high water level, may also be seen at Hawkes Bay, to the west of Karachi. Concerning similar deposits near Cape Monze, Blanford says: "At the jutting rocky point on the eastern side of the Hab, opposite the sandspit that forms a bar at the mouth of the river, there is a raised oyster bed about 50 ft. above H.W.L. There are also oyster shells attached to the rocks about 10 ft. to 15 ft. above H.W.L. east of Cape Monze".

(b) **Old Alluvium.**—In the lower Hab Valley, the river has cut through its old alluvial plain, leaving a wide terrace on either side. The old alluvium of the Malir and the Lyari is not so prominent within our area. In gullies near the Orangi, however, quite thick deposits can be seen overlying the Pleistocene conglomerate.

(3) **Recent:** These are of three kinds: (a) **Beach Deposits.**—In the neighbourhood of Clifton, the beach is largely composed of dark grey silty material with minute flakes of mica. Black muds and sands are common on the sea floor off this coast and is probably of similar composition. It was suggested by R. D. Oldham that much of the material of this beach is derived from the spoil ground for the dredgings of Keamari Harbour, as the dumping area is located off this shore. Fine material is carried to the sea by way of the Malir and the Lyari when in flow and part of this is thrown back upon the beach. As the strongest ocean and littoral currents flow eastwards, it is doubtful if much of the Indus silt reaches the area.

The beaches are subjected to the pounding of a heavy surf from June to September, due to the S.W. Monsoon. Shell and other material are quickly fragmented under these conditions. Once thrown upon the beach, this material, when dry, is liable to removal by the wind.

Beyond Manora, at Hawkes Bay the beach deposits present a more normal aspect.

Where there are no appreciable beaches as at Manora point and Oyster Rocks, active marine erosion continues.

(b) New Alluvium.—The Malir and the Lyari rivers have brought quantities of alluvium to the Karachi area and continue to do so during rainy periods. Much of Karachi is built upon the alluvial flood plain of the Lyari, whilst that of the Malir forms a wide expanse between th Drigh Road-Ghizri Hills and the Ibrahim Haidari-Landhi rise. These plains extend for some miles, that of the Malir terminating beyond the Malir-Bazar confluence and is about twice the length of the Lyari.

The process of alluviation continues during flood periods, when quantities of silt are transported. The formerly important Ghizri Bunder is rapidly silting up, as is also the marshy area off Keamari into which the Lyari leads. It was the partial silting up of the Hab River mouth that caused Kharak Bandar to be abandoned by coastal craft in favour of the Karachi lagoon. The Keamari harbour is affected in this manner and dredging operations are necessitated, although certain harbour-works have also been erected to assist tidal scouring action.

The alluvial deposits of the Malir and the Lyari, especially the former, are important as water-bearing strata. The original water supply of the city was drawn from the Lyari bed as said before, but later on a system of wells have been sunk near Dumlotte, beyond Malir. As the sea is approached, water is often reached within twenty feet but is often contaminated.

The Post-Tertiary Conglomerate and Manchar rocks provide much of the alluvial material and consequently numerous pebbles, derived from the former source, are found in the beds. In addition, a great quantity of silty material, originally carried to the area by wind action, is added to the beds. Not all the superficial deposits of the alluvial plains have been brought by the flooding rivers. During the S. W. Monsoon rains, the normal run-off from the elevated areas considerably adds to the quantities of surface dust and sand.

The transported sediment, that reaches the sea, is deposited and adds to the bars that lie across the creek mouths or forms beach deposits, enlarging the mud flats and sandbanks. Finer material is carried seawards and eventually sinks to the sea floor, off the coast. At the ten-fathom-line, about five miles offshore, the sea bed is of fine black sands and muds,

Gulleys are often prominent in the alluvial plains. These are formed and enlarged during the rainy periods when, as has been mentioned, large quantities of silt are shifted. The Malir-Landhi road is especially liable to obstruction by silt, redeposited by receding waters.

(c) **Wind-Borne Deposits.**—The wind agency help to form the numerous sand-hills, which have added to the coastal landscape and which have been already mentioned in Section A.

As stated therein, both crescentic and 'whale-back' dunes occur, although the former are rather more common. Of these, there is a rounded onset side, sloping comparatively gently and a steeper lee-side, disturbed by air eddies in the middle. The two arms usually differ in length but the general shape is indicated in a photograph. 'Whale back' dunes are elongated in the direction of the wind. One or two of these are to be found in the plain between Ibrahim Haidari and Drigh Road. (See Plate VIII, No. 16).

Close to the sea, calcareous grains and fragments of the sea shells make up quite a large percentage of the bulk of the dunes. These grains are frequently coloured and give parts of the dunes a red brown colour. Fine quartz sands occur more prominently in the sand-hills away from the immediate vicinity of the shore. Here, mica flakes also occur. A microscopic examination of the sands shows that rounding of the grains is usually only in its first stage. (See Plate VII, No. 1).

R. D. Oldham's report on the "Sand-hills of Clifton" included the suggestion that much of the wind-borne material is derived from the dredgings of the Keamari Harbour. He also made suggestions for the control of the dunes. In view of the fact that a promenade has been planned to extend into the sandy regions near Clifton, this problem must be carefully considered. A project for the construction of a colony near Ghizri was abandoned in favour of another site with a view to avoiding blown-sand nuisance. The erection of solid walls causes deposition on the windward side and the eventual engulfment of the obstacle. Hedges induce deposition to the lee-ward. Villages in this area frequently erect wind-breaks of brush wood that have this effect. Oldham himself suggested the use of rigid but permeable barriers. Oldham's finding also was that nearly 60 per cent of the sand was derived from sea shells.

The Physics of Sand Hills.

During the period of the S.W. Monsoon, that is from April to September, the coastal districts of Sind and the neighbouring Las Bela and Makran coasts are subjected to winds of an average velocity of ten to twenty-five miles per hour. This is sufficient to raise a dust haze and transport a considerable load of sand, some of which is deposited in the neighbourhood of Karachi, either in the form of sand dunes or heaps, banked-up against rock outcrops. Dunes are frequent, especially along the coast where they sometimes reach large proportions. As has been noted, the sand-hills are on the move, as a whole, to the leeward, unless they are naturally anchored by grasses or in a shielded position. They are subject to every variation of the wind and according to the conditions, e.g., velocity, direction of the wind, etc., alter in size, shape and orientation or may be completely removed. The slightest obstacle being sufficient to institute a dune, they build up from a small deposit behind a pebble or a blade of grass. Once instituted, a larger obstacle is presented to the wind and more material may be deposited, the hill thus actually assisting its own growth. Where tufts of coarse grass are growing fairly closely spaced, the sand is more evenly deposited and results in a sandy area of small hummocks, all elongated in the same direction. Such is the case in some parts of the Ghizri creek and Lower Malir valley region. A large expanse of wind-blown deposits occurs near Clifton and S.W. of the Ghizri hill. In the creek regions also, dunes are built near the sea and although the material is being constantly removed and blown inland, fresh material is always added. The areas, subject to wind-borne sand deposition, remain fairly constant. A possible reduction of the dune areas might be effected by the dumping of the dredging material somewhere else. Whether this would greatly alter the situation is, however, doubtful. Xerophyric grasses are encouraged in France and Holland to naturally anchor the dunes. Such grasses do live to a certain extent within this region and their growth should also be encouraged here.

(d) Salt Efflorescence.—This generally produced on damp surfaces in the valleys, the salt being derived from the underlying marine rocks.

SECTION C :—HISTORICAL GEOLOGY

1. GEOLOGICAL HISTORY OF THE REGION.

From the Mid-Palaeozoic to the Mid-Tertiary, a geosynclinal sea separated the northern mass of Laurasia from the southern continent of Gondwana, of which there are now only remnants from its break up, completed in the Cretaceo-Tertiary age. This Tethys sea, lying from east to west almost straight from the Mediterranean to the Tongking regions, fluctuated considerably in depth over space and time, its margins varying correspondingly. The Sind region, in company with the Iran Plateau, frequently lay within the confines of the Tethys, and the Tertiary rocks, laid down in it or in ramifications of it, are now excellently exposed, making these regions type localities for their study.

Cretaceous rocks are the oldest strata that are exposed in Sind. At the base of Burrah hill, in the Laki range, a **hippuritic** limestone is shown. This and the dark sandstones of the associated series indicate marine conditions of deposition. The Tethys, a deep gulf of which had occupied the present Salt Range area, western Sind and Baluchistan and had overspread Cutch, was now coming to the end of its long history and was rapidly shallowing, as the detritus from the neighbouring land was carried into it. With the filling of the geosyncline from the material derived from the great Aravallis, the isostatic equillibrium was distributed and a stupendous series of earth movements, which had been long pending, was instituted, marking the culmination of the Mesozoic period. These movements involved the upheaval of the Himalayas in addition to many other massive mountain ranges throughout the Old World. Sind was affected just by the fringes of the orogenesis and the rocks are folded in accordance with the four phases of the Himalayan uplift viz:—

1. Upper Eocene ... Pre-Nari.
2. Middle Miocene ... Post-Gaj.
3. Close of Pliocene ... Post-Manchar.
4. Late Pleistocene ... Post-Tertiary Conglomerate

Outpourings of fissure lavas accompanied the earlier movements and these are represented in India by the Deccan Trap. A bed of highly decomposed basaltic trap of the same age does occur in the Laki range. The Tethys, now having been partially

destroyed, quite extensive Ranikot deposits were laid down, first as fluviatile but later as marine beds, when the sea was temporarily re-established.

The Kirthar series of limestones and soft sandy and shaly rocks were laid down in the Eocene sea. The large foraminifera, the nummulites, flourished and continued into the Lower Nari seas, which were formed in the troughs of the Kirthar beds and folded in the Upper Eocene age. The Upper Nari rocks are largely fluviatile and non-fossiliferous, although a marine phase is recresented by the orbitoides limestone.

During Miocene times the Karachi area was occupied by a shallow gulf of the sea. This was teeming with life and some of the limestone beds are full of fossil fragments. As might be expected in the case of comparatively shallow-water deposits, there was some variation in physical conditions, which are now indicated by the alternating beds of limestones, clays and sandstones, some of the latter being cross-bedded. The presence of the coral beds at Mangho Pir, as has been mentioned before, gives us an indication of the conditions that existed on the occasions of their construction,—a warm, clear but shallow sea.

The marine deposition of the Gaj period was interrupted by further earth movements and the largely fluviatile Manchar sedimentation followed. The Tethys had already disappeared, leaving a few remnants, and by this time India had become an integral part of Asia.

The Manchar sandstones of the Karachi area seem to show that the sea was at no time far distant and that they are possibly the products of a great river delta. Minor fluctuations of land level produced temporary marine invasions, during which the fossil layers e.g. the marine bands, were deposited. The marls, sometimes reminiscent of some of the Triassic marls of England, are occasionally gypseous. These beds were probably deposited in an enclosed portion of the sea or a gulf with a small outlet to the sea. Manchar sediments suffered partial denudation during the Upper Pliocene, having been folded during the earth movements of the period.

A general cooling of the climate heralded the Ice Age and with it the Pleistocene period. The Post-Tertiary conglomerate was thus laid down as a fluviatile deposit and subsequently slightly deformed by the late Pleistocene movements. This folding was

superimposed upon the earlier folds of the Mangho Pir—Cape Monze structures, which were probably instituted in the Middle Miocene.

The basis for the development of the present-day physiography had now been formed and from this plan the present scenery has been produced by the triple processes of denudation, transportation and deposition.

The general alterations of land level have continued and are still continuing. In a manner similar to the Orissa, Malabar and other Indian coasts, the coastal regions of Sind and Makran have comparatively recently been below the surface of the sea. During the process of an uplift the shoreline was temporarily stabilised at the now abandoned cliff positions at Clifton, Ghizri and the Ibrahim Haidari ridge. Another slight uplift, helped by the silt brought down by the Malir and the Lyari in addition to the material thrown on the shore by the sea itself, has caused the further retreat of the sea from the above regions in recent times.

This geological story has been represented diagrammatically in Plate VI, figs. I to VII.

(1) Explanation of Diagrams.

In this diagrammatic representation of the geological history of the Karachi area, (I) shows Nari sediments being deposited in the waters of the Nari sea. This is followed by the second phase, when sediments are laid down upon the Nari rocks in the shallow Gaj Sea (II). These are folded during the middle Miocene (III) and the Manchar fluviatile sedimentation follows (IV). Further compression (late Pliocene) disturbs the Manchars which suffer partial denudation (V), before the Post-Tertiary conglomerates is deposited (VI). Late Pleistocene movements slightly accentuate the folding (VII). Denudation has revealed Nari rocks in the core of the Mangho Pir anticline.

(2) Explanation of Geological Section, across Karachi and its Neighbourhood.

The line of the Section is taken from S.S.E., Goth Ibrahim Haidari approximately N.N.W. to Mangho Pir, then West to include the western limb of the Mangho Pir anticline. At the south-eastern end, Manchar deposits outcrop in the Ibrahim Haidari ridge and in the low hill near Bambo Khan Karmati, with

a capping bed of Post-Tertiary Conglomerate. The Manchars become concealed under superficial deposits, as they dip into the syncline of the Malir Valley. They are still further concealed in the northern limb in this section, but the Gaj rocks outcrop in the Drigh Road dome. The Lyari syncline alluvium also conceals the Manchar rocks on its Drigh Road side. Nari strata, which have been concealed under overlying Gaj and Manchar rocks, are brought to the surface as an inlier in the Mangho Pir anticline, shown at the north-western end of the Section.

Thus the oldest parts of Karachi and its neighbourhood are the Mangho Pir and Hab Valley areas, while the youngest are the sand-hills tracts. The others are geologically intermediate in age, though still in the processes of denudation, transportation and redeposition. (See Plate IV.

(3) Palaeontology.

Many of the Nari and Gaj beds are fossiliferous and there are also occasional shelly bands in the Manchar series. Towards the top of the Nari, outcropping west of Mangho Pir and continuing towards Cape Monze, a marine bed contains numerous foraminifera, mainly Orbitoides. It also contains echinoids and mollusca, especially pectens. The Gaj limestone horizons are usually fossiliferous and the outcrops, cut by the Mangho Pir road, offer a good hunting ground for fossils. Echinoids occur and there are numerous Molluscan remains. The coral beds are easily found. In some of the Manchar marine band, exposures of gastropods are prominent. Bone fragments are also quite common and fossil wood has been noted. Oyster shells and bone fragments were observed by Blanford in the Post-Tertiary Conglomerate of Oyster Rocks. More modern are the abundant shells of the raised shell banks.

Thus, the region abounds in Tertiary fossils of a remarkable character. The Gaj rocks, especially, are rich in remains of the lower Miocene age, mollusca, anthozoa and echinoids, of which some examples are given below. In fact, a good literature on the palaeontology of Sind has been already produced and the region of our study has been proved to be of special interest in this direction. The Sind Tertiaries, being some of the best of their kind in India, have given their name and terminology to rocks of the same geological age found throughout the country of India.

A list of Fossils specifically mentioned as occurring near Karachi.

Mollusca (I).

Ostrea mullicostata. Manchar, Malir.

Ostrea lalimarginate. Vredenburg. Gaj. Kadeji Gorge.

Ostrea gajensis. Verdenburg. Gaj.

Ostrea cucullata. Born Manchar (?) 7 miles W. of Karachi.

Pecten (Aequipecten) scabrellus. Lamark. Gaj. W. side of Lal Bakkar.

Pecten (Chlamys) feddeni Vredenburg. Gaj near Mangho Pir.

Pecten subcorneus. Nari, Mangho Pir.

Cardita muricata. Sowerby Gaj.

Surcula tuberculata var voyseyi (d'Archiac and Haime) Gaj, Karachi.

Olivancillaria (Agaronia) Nebulosa. Lamarck, var pupa J. de C. Sowerby. Gaj, Karachi.

Athleta (Volutospina) denutata, var sykesi d'Archiac and Haime.

Lyrice jugosa (J. de C. Sowerby) Gaj, Karachi.

Mitra (Cancilla) rembangensis Martin. Gaj, Karachi.

Metula martini. Vredenburg. Gaj, Karachi.

Tritonidea (Cantharus) bucklandi (d'Archiac) Gaj, Karachi.

Nassa Telasco) faloneri (d'Archiac and Haime) Gaj, Karachi.

Nasa (Hima) Vicary (d'Archiac) Gaj, Karachi.

Murex (Haustellum) tchihatcheffi d'Archiac and Haime Gaj, Karachi.

Muricopsis exhexagonus Vredenburg. Gaj, Karachi.

(I) M. G. S. I. Vol., L, Pts. I & II.

Hindsia granosa (J. de C. Sowerby) Gaj, Karachi.

Ranella (Biplex) bufo J. de C. Sowerby. Gaj, Karachi.

Ranella (Apollon) morrisi d'Archiac and Haime. Gaj, Karachi.

Cassidaria desori d'Archiac and Haime. Gaj, Karachi.

Cypraea prunum Sowerby, var Nasuta Sowerby. Gaj, Karachi.

Cyprea (Bernayia) subexcisa Braun Nari.

Cypraea (Bernayia) humerosa J. de C. Sowerby. Gaj, Karachi.

Strombus sedanensis Martin. Gaj, Karachi.

Strombus (Gallinula) Columba Lamarck. Gaj, Karachi.

Telescopium Fuscum (?) Manchar, Malir.

Anthozoa (II).

Antillia indica, Duncan, Gaj, Lal Bakkar.
Dasyppyllia sp. Gaj near Mangho Pir.
Leptomussa rugosa, Duncan, Gaj near Mangho Pir.
Monticulastrea insignis, Duncan near Mangho Pir.
Heliastrea sindiana, Duncan. Base of Gaj, Mangho Pir.
Latimaeandra paroula, Duncan. Gaj, Mangho Pir.
Latimaeandra gajensis, Duncan. Base of Gaj, Mangho Pir.
Prionastria gajensis, Duncan, Gaj, Mangho Pir.
Cladocora haimei, Duncan, Gaj S. of Mangho Pir.
Echinopora maxima, Duncan, Gaj S. of Mangho Pir.
Cycloseris magnifica, Duncan, Base of Gaj near Mangho Pir.

Echinoidea (III).

Cidaris opipara Duncan and Sladen. Gaj, Mangho Pir.
Clypeaster profunclus (d'Archiac), Duncan and Sladen. Gaj N. of Karachi.
Clypeaster pelviformis Duncan and Sladen. Gaj S. of Mango Pir.
Echinolampas jacquemonti, d'Archiac and Haime. Gaj, Khadeji gorge, Churna Island.

(I) M.G.S.I., Vol. L., Pts. 1 and 2.
(II) Pal. Ind. (Ser. VII, XIV) Vol. I, Pt. I (New) 2).
(III) Pal. Ind. (Ser. VII, XIV) Vol. I, Pt. III, Fas. 5.

2. GEOLOGICAL HISTORY OF THE NEIGHBOURING INDUS DELTA.

The Indus river is a singular artery running through the whole body of Sind. Its delta, of which the Karachi district forms part, is built from the soil of a continent and is a growth of milleniums from late Tertiary times. It may have formed the lower part of the Indo-Brahm or Siwalik river, which carried the combined rivers and eroded silts and earth detritus of the Indus, the Jamna-Ganges and the Brahmaputra through this region in a reversed direction and ultimately fell into the sea beside Cutch and Kathiawar. The presence of Manchar beds, all around the area of our study, is a proof of the existence of such a great river in late geological ages and the discovery of a deep gully and submerged ridges in the Arabian Sea off the coast of Sind on both the sides, made by the Murray Expedition of 1933-34, helps to confirm the hypothesis. Lt.-Col. R. B. Seymour-

Sewell, the leader of the Expedition, has described these features clearly.

"Between Ras al Haad and the Indian Ocean in the neighbourhood of Karachi, the echo-sounder clearly revealed the presence of a submarine ridge that runs westward towards the entrance to the Gulf of Oman, more or less parallel to the hill ranges of Baluchistan and Makran. To the South of this ridge and separated from it by a level plain with a fairly constant depth of 1,850 fathoms lies a second ridge that runs towards the south-west, and immediately to the south-east of this is a deep gully, bounded in its turn by the edge of a plateau that slopes gradually downwards towards the south-east.

The bottom of this gully lies 2,000 fathoms below the surface of the sea and its general character reminds one strongly of a river bed. It seems to me that we have here either the new submerged bed of the Indus where it flowed into the Arabian sea along a line to the northward of its present course or perhaps the mouth of the great Indobrahm river, the existence of which was postulated by Pascoe and Pilgrim."

The westernmost end of the Indus delta, which is continuously growing at present at the rate of about 4 yards per year, just touches the Ibrahim Haidari promontory and it is likely that some of the Indus silt was carried into the Keamari harbour by the sea currents, as the presence of mica in the sands derived from the dredgings, thrown off Clifton, indicates.

SECTION D :—TECTONICS

Being at the fag end of the Extrapeninsular mountains and lying very near the sea, the Sind Kohistan area has not greatly suffered from tectonic movements. The highest ranges do not now rise even upto 3,000 feet and there are no great contortions, compressions or distortions of the strata. The tectonics of Sind are, therefore, simple, though not without some interesting features.

1. Folding.—The solid rocks, with which we are dealing, have been thrown into a series of comparatively wide folds. The resultant outcrops form the southerly extension of the Upper Sind ranges. Within our area, the axes tend to lie approximately S.W.-N.E., but beyond Mangho Pir a northerly direction is assumed. The folding is most pronounced westward and fades towards the east. Regarding the origin of the disturbance, Dr. H. Crookshank has said that "the rocks round Karachi have been subjected to lateral compression acting in N.W. and E.N.E. directions. By far the most important has been the north-westerly one, which has bent the rocks N.W. of Karachi into sharp folds. Its effect gradually died out to the S.E. The E.N.E. compression has been on a much smaller scale but it has disturbed the strata in Kalat and Mangho Pir, where dome structures are well developed." Its effect can also be noted at Cape Monze and at Drigh Road.

The series of hills, bearing inland from the Cape, the Jhil, Moach and Golomani ridges, form the eastern limb of the Lower Hab valley anticline. The Gaj beds are repeated at the promontory itself by a fold with its axis running approximately N.N.E.-S.S.W. Following the range inland, it veers more easterly and the dips become southerly. At the head of the Layar Nadi, the strata are more irregularly disturbed but re-assume the paralleled, ridge outcrops immediately to the east in the western limb of the anticlinal structure at Mangho Pir. Here the dips are S.W. but, as the fold dips sharply in the south, they do become S.S.E. and eventually E. on the eastern limb. The main axis runs approximately north and south, the eastern outcrops extending northwards beyond our present area and the western limb turns to extend into the Jhil range.

The River Lyari flows across Manchar beds still preserved in the trough of a shallow syncline, into which the strata exposed

in the Mangho Pir area pass. The axis lies in a N.E. by N.-S.W. by S. direction. It pitches at a very low angle to the S.W. and flattens out about 10 miles N.E. of Karachi. The Malir valley is also a shallow syncline and Manchar rocks are preserved in some parts of it, although mostly obscured by alluvium. The synclinal axis here is approximately N.E. by E.-S.W. by W., dips being low, generally not greater than about 6 deg.

Separating the two synclinal troughs is the Ghizri-Drigh Road anticline, which pitching in the W.S.W. and E.N.E. at low angles, might be better termed an elongated dome. The long axis lies N.E.-S.W., the fold flattening and passing beneath the Manchar deposits about 10 miles N.E. of Karachi.

The Manchar rocks occurring at Ghizri, Clifton, Oyster Rocks and Manora are remnants only of the continuous belt, which once skirted the south of this structure.

The ridge of conglomerate-capped Manchar deposits, that commences near Ibrahim Haidari on the further side of the Malir Valley from Karachi Cantonment, forms the marine denuded remnant of a very low anticline. To the N.E. the slight warping of the rocks flattens out. The fold represents the outermost traces of the Mangho Pir-Cape Monze disturbance.

2. Faulting.—The rocks in the area are only slightly faulted. About five miles north of Mangho Pir, a fault occurs crossing the strike from the neighbourhood of the Lahro Nadi to near the small village of Goth Pithai in an E.S.E. direction. It cuts both Nari and Gaj strata. Small faults occur to the south of this, often marked by breaks in the ridges. In the Jhil, Moach, and Golomani range, there are three breaks caused by faults in the same direction as that above. From north to south they are marked by the Golamani Pass, Lal Bakhar Pass and Soma Pass.

The hot springs at Mangho Pir must mark the line of a fault. Assuming the temperature of the issuing water to be due to the ascent from the depth due to release of pressure, the fissure would be at least 4000 feet deep, making due allowances for absorption of heat on the way.

The Manchars and Post-Tertiary conglomerate display only occasional minor fractures.

3. Slips.—Over and above these areas of minor faulting, we notice also occasional slips in the rocks, exposed in the numerous escarpments, all along the coastal hill ranges e.g. Old Clifton and Clifton hills.

4. Earthquake disturbances.—Sind, again, falls within the danger zone of North-West India. A good part of it actually lies within the range of severe earthquakes recorded since 1850 e.g. the Mach earthquake of 1931 and the Quetta earthquakes of 1905 and 1935, as has been shown by Dr. W. D. West. Now and then shocks are felt even at Karachi though not of a severe character. The growing Indus delta must also be causing a disturbance in the equilibrium of these unstable rocks. Any damage or change in the hydrography or orography of the land must, however, be only of a local character and not on any wide scale. The only serious danger to Karachi is from the direction of the sea, if a seaquake occurs and the low lying areas (hardly a few feet above sea level) are submerged any time. The chief cause of these earthquakes is that the young Tertiary rocks in the Western Highlands are still in the process of settling. Their stresses are relieved gradually and continuously in the re-entrant angle lying in the Bolan Pass, where the mountain ranges are bent, resulting in a considerable strain of the rocks slipping or getting fractured.

(1) The Mach Earthquake of 1931.

In the case of the Mach earthquake such a situation had arisen, and Karachi lay within the isoseismal lines 4 and 5, the isoseismal 4 extending right upto the Indus valley. As usual it was noticed that "places situated on alluvium suffer more severely during an earthquake than places situated on hard rock, through which the waves passes more quickly". Where consolidated rocks occur at the surface of the ground, as parts of the city of Karachi are situated, the intensity of the shock is always less. But the junctions of solid rock and the alluvium are worse off in this respect. At Karachi, the shock during this earthquake was estimated "to have lasted from 10 to 30 seconds and to have manifested itself as regular oscillations at the rate of about 3 a second, and in a north-and-south direction. It was most apparent in the upper storeys of high buildings, where light furniture moved and unsecured articles fell to the ground". The nearest epicentre of an earthquake to the limits of Sind during the last hundred years was near Karu in the Kirthar Range in 1869.

(2) The Earthquake of 28-11-1945.

This, the latest earthquake, was felt all throughout Sind at 3-29 a.m. and lasted for about 30 seconds. In the city of Karachi, people felt the tremors very clearly, the beds rocked in the north-south direction, the cupboards, doors and windows rattled and the hanging lamps swung to and fro.

At Manora, the 80-ft. high lighthouse rocked so much that from the mercury tray, in which its delicate machinery is kept floating, nearly 30 lbs of mercury spilled over on the concrete floor and in the observatory at Cape Monze some 22 lbs of mercury were similarly thrown out. Cracks were also found in this lighthouse.

But the most extraordinary incident in connection with this earthquake was the occurrence of a tidal wave, which followed the earthquake a few hours later and developed a speed of about 140 miles per hour. The waves touched our shore 3 or 4 times, the last and the biggest wave came at 8-15 a.m. and rose to about 12 feet on the Keamari side. It actually broke some 400 feet of earth from the Keamari Groyne.

This tidal wave caused much damage to the fishing villages along the Sind Coast. About 15 miles south of Ibrahim Haidari, the fishermen experienced a terrible kind of churning and convulsing movements and many boats were smashed to pieces. Some villages were wholly washed off and several lives were lost. Shoals of fish were carried inland and thousands of them were left dead by the retreating waters.

A lucky circumstance, so far as Karachi was concerned, was the difference in the timing of the tidal wave and the time of the usual tide. The maximum tide, caused by the seaquake, occurred about 100 minutes after the normal high tide, so that it nearly coincided with the ebb time. Otherwise, if the waters of the tidal wave and those of the high tide had synchronised, Keamari and the surrounding parts of Karachi, which are hardly 5 feet above the sea level, would have been under water in no time.

But the greatest loss of life and property has been reported from the Makran coast and it appears that the epicentre of the earlier earthquake, which preceded the seaquake, is in the region of the Hingol valley. One of us, who visited these parts, found a great deal of disturbance in them. Rock falls and cracks have

occurred along the slopes of the Makran range and in the superficial deposits of the desert floor in the S.S.E. direction. A mud vent, in the Huro Range, slightly north of the peak, which is 1816 feet high, had the appearance of a renewed activity. At Kund, people saw a strange light for several hours and it seems as if gas escaped from a fissure and caught fire by friction during the disturbance. The mud volcano of Chandragup, situated about 20 miles towards the south-east, has also recently overflowed and it is quite likely that the partially dried mud flows, on its upper slopes, were produced during this earthquake period. Landslides have taken place even at Ormara and Pasni where the tidal wave rose to some 40 ft.. Strangely enough two uncharted islets have appeared approximately in the lat. 24 deg. N. and long. 64 deg. E.

All this must be due to disturbances along the line of fault parallel to the Makran Coast and beside the submerged ridge discovered by the Murray Expedition. Further investigation of this one of the most interesting earth disturbances, in the neighbourhood of Karachi, has been awaited.

5. Signs of Vulcanism.—The Mangho Pir hot-spring has been already referred to as a result of faulting in an anticlinal fold and there are numerous such springs with calcareous tufa round about them, from fractured anticlines in the whole of the Kohistan area, but they are not deep-seated and have no connection with the internal magma. Beyond this, there is no vulcanism marked in the region of Sind. At times, eruptions of warm water and muds are noticeable in and near the delta region. A tidal bore was recorded in 1903 in the Shahbandar Taluka, near the town of Sindree, which was submerged on the occasion and a number of small cones, a few feet high, burst up from the ground and continued for some days to emit bubbles of air and mud from their summits. Some of the "mud volcanoes" found along the Makran Coast in the west of Sind, are also considered to be of a superficial character.

SECTION E:—GEOMORPHOLOGY

From the ground plan of the folded rocks the present scenery has developed under subaerial erosion, except in some coastal tracts where the sea has played its part. The principal agencies of erosion, which have been in operation in this area, are: 1. Winds; 2. Run-off waters, and 3. the Sea.

1. **Winds.**—The S.W. Monsoon blows steadily for about six months of the year and is generally of sufficient strength to cut down the rocks and to bear a load of sand and dust, which carves and polishes rocky outcrops. Seeking the less resistant beds and bedding planes, the wind agency plays its part, the stronger layers being undermined and getting eventually eroded. This results in wierd forms of rocks denuded differentially e.g. Mangho Pir. The soft-bedded Manchar sandstones are particularly susceptible to this action. The foldings of the strata and the jointed and barren condition of the rocks help greatly in the process of weathering. The saw-like structure, developed by the wind agency, is prominent on the windward side at Mangho Pir. Chemical weathering is slight. The climate is too dry for it to be appreciable except in rocks with capillary spaces, which allow the ascent of ground water.

2. **Surface run-off.**—The rainfall of the whole year is completed generally within a few days and this is the period when the run-off, unchecked by any vegetation, carves gullies out of the softer rocks, widens the old ones and shifts great quantities of silt and rubble. This subaerial weathering is, however, a slow process.

3. **Sea erosion.**—In the coastal tracts the sea has been at work and marine erosion being more rapid than the subaerial denudation, cliffs have resulted. As has been noted before, due to the recession of the sea many of these cliffs are now abandoned by the sea and are subjected to the work of wind and rain alone, resulting in rocky escarpments.

4. **Evolution of Landscape.**—The nature of the rocks being alternatively comparatively hard and comparatively soft bands and the manner of their folding pronounced in the west and gentle in the east of our area, nature has produced two types of hills. The Mangho Pir region, with its anticlinal folds, has been denuded probably of some 1500 feet of rock, now exposed in the

Gaj and Nari beds sharply inclined. Ridges have developed where there is a durable layer, as, for instance, in the Orangi and Ghora Lakki outcrops, and in synclines, where the softer beds have been removed by differential denudation. The sharp escarpment and less severe dip-slopes are easily recognisable as outcrops of more resistant beds. The same occurs in the Hab Valley where such regular ridges as Kochani and Dumorio are found, apart from the main range of hills. In contrast to these parallel series of ridges there are the flat-topped hills and islands which occur where the dip is low. Here there is a tendency towards the formation of buttes so typical of arid regions. This is the case of some of the local Manchar outcrops. These soft sandstones would not have endured to such an extent, however, had it not been for the presence of the capping and protecting Post-Tertiary conglomerate lying unconformably upon the Manchars. This resistant layer forms the flat top of Clifton, the Ibrahim Haidari ridge, the outcrop near Ghizri and elsewhere. As the dips are very low, the hills do not rise to a sufficient height and due to the hard conglomerate cover, they do not bear any vegetation.

The form of these flat-topped hills has also been preserved by the conglomerate, which has restricted the development of gullies. In the coastal tracts some of the Manchar hills, e.g. Manora Rock, have been subjected to marine erosion and their steep cliff sides are partially due to this and partially due to the conglomerate.

5. **Rise of Level.**—The sea has retreated with the elevation of the land with a few cliffs left behind and the accumulation of material along the whole shore. Thus, Clifton and Bath Islands are now connected to the mainland, although at one time they must have formed rocky islets. The same applies to other parts of the coast including the ridge at Ibrahim Haidari, which doubtless formed a rocky promontory. The planes of marine denudation, as those near Mauripur and Clifton, have also been similarly formed. These planes are even now rising in level due to the accumulation of muds brought in by every high tide and vast areas are ready for reclamation round about them, e.g. the area on the east of Clifton Road.

The creek areas, east of Ibrahim Haidari, became extensive with the elevation and further east the Indus silt is continually accumulating. The rate of the growth of the delta is estimated at about four yards per year, although it must have been more

rapid in the past. No Indus water now reaches the sea by these most westerly creek ramifications of the river, but it seems probable that in the past a branch of the river flowed as far as Ibrahim Haidari promontory. The lower course of the Indus being unstable, this branch has now disappeared and there seems to be a tendency for the river to chose more easterly mouths, although its course in Upper Sind seems to be westerly. The positions of the edge of the delta in different times has been estimated as follows:—

Period.	Average distance inland from present shoreline.
1. Prehistoric	36 miles
2. Greek	16 „
3. Arab	6 „
4. Middle Ages	2 „
5. 18th Century	½ „

These figures, being the average for the delta, are greatly in excess of the immediate Karachi area which marks the westward limit.

6. **Development of the Coastline.**—A further recently developed feature of the coast is the Karachi lagoon, the manner of utilisation of which for Keamari Harbour is noted later. Although now largely silted up, the area that it covered was over 20 square miles, being some ten miles long and three miles wide at its broadest point. A rather similar but more extensive lagoon is the Miani Hor, west of Cape Monze and at the head of Sonmiani Bay. The Cape itself is formed by the comparatively durable Gaj and Nari rocks which are brought up to the surface. Churna Island stands as a remnant of the past seaward extension of the Cape. The Oyster Islands, too, were originally continuous with the present Manchar outcrops of the mainland but by differential marine erosion they have been separated and all that remains are the islets and sea stacks.

7. **Changing Hydrography.**—The Hab, the Malir and the Lyari apparently were all more active in the past than at present. The Manchars are, therefore, largely denuded and the comparatively wide alluvial plains are the result. All these three rivers are strike streams and flow almost parallel to the hill ranges. Thus they have few chances within the area to change their courses.

The last two rivers struggle hard to form their own deltas, the one within the Ghizri creek and the other beside the Keamari harbour, and to gain mastery over the sea; but their flow being restricted to only a few days in the year, the sea succeeds in cutting them away to some extent.

The Malir and its tributaries now drain one formation only, the Gaj, for the major portion of its length. Occasionally it flows through shallow gorges indicating a more active career in the past. Few streams or gullies cut the ridges, an exception being the Orangi Nadi, which, flowing along the strike, ultimately cuts the outermost Mangho Pir ridge at right angles and forms a gorge at a low level.

Lastly, the unstable sand-hills complete the picture of an arid and otherwise uninviting coastland, as seen from the sea.

On the whole, Karachi combines the characteristics of the Kohistan hills and the coast both in its physiographical features and its scenery. Its dry neighbouring rivers, its sea front, its powerful periodic winds and land and sea breezes, and above all, the solar heat, all help in shaping and reshaping its landscape. Devoid of many trees and other lururiant growth, both on the hilly parts and in valleys, the scenery is dull and unattractive, but in the exposure and outline of rocks and the fantastic forms of shifting sand, nature is indeed superb.

SECTION F:—ECONOMIC GEOLOGY

The exposed rocks contain no important economic minerals in workable quantity. They can be utilised, however, for several purposes. The water-bearing strata are of special importance and it is also possible that a petroleum reservoir is concealed in the Drigh Road dome and other neighbouring anticlines.

1. Limestones.

The limestone horizons of the Gaj outcrops are extensively quarried in the Ghizri-Drigh Road hills and to a lesser degree in the Mangho Pir, the Hab and other areas. The quarries are open and generally quite shallow in depth, since this is controlled by the passage of the beds into less suitable material and the water table. The rock is utilised at present for building stone, road metal and foundation for railway tracks, also for cement and lime manufacture. It is generally not very pure for direct use in many chemical industries and in some areas varies considerably in composition.

The older Ranikot and Kirthar rocks are far better in this respect, their calcium contents being high.

(1) Building Stone.

As a building stone, the limestone is satisfactory for most constructional purposes and has been used extensively in Karachi for all types of buildings, also for bridges, embankments etc. The jointing is rather close, crooked and irregular and the horizontal bedding planes, though apparently obliterated, are not far apart. Thus the size of the blocks is usually restricted to about a cubic foot. The stone is, however, easily worked and although the products of different quarries have different characteristics, it is fairly durable for the climate. The limestone from the Hab quarries is distinctly ferruginous and is used where larger blocks for corner stones and for facing are needed.

The Ghizri Quarries produce some good stone. They are worked on the strike side and although the dip angle is small, the numerous joint planes together with the few bedding planes facilitate the work of quarrying and blocks slide down conveniently.

The stone is worked up to a fine edge which endures quite well, and takes a good face. The colour is light buff and is lighter in shade than that of the limestone in other areas. According to the purpose for which it is required, it is rough dressed, smooth faced or hammer-and-chisel dressed. The mode of construction usually employed with the prepared stone is followed. The material from Drigh Road and Hand's Hill Quarries suffers from variation in composition and will not normally take such a good face or edge as the Ghizri product. It is, however, suitable for many building purposes and has the advantage, together with the Ghizri stone, of being in close proximity to the city.

Further quarries are situated on the dip slope of the Gaj outcrop near Orangi. Near Mangho Pir and at other places, tombstones, presumably obtained from local outcrops, are found. Some of these are quite old and the carving partially obliterated, the process of weathering accentuating the minor bedding planes. Generally, however, the stone weathers well owing to the comparative dryness of the climate. Where noticeable weathering occurs, it is most obviously close to the ground when it is damp. This can be largely eliminated by the construction of buildings with proper damp courses.

Limestones, which might be imported to Karachi, include those of Jherruck, which, being good for carving, have been used for tomb-stones and memorials, and the Kirthar limestone of Sukkur which, though very good, is hardly worth transporting to Karachi. The last also contains flint nodules of good size. The lithographic ornamental limestones of the Kirthars are too far situated to be suitable for use in the city.

The most durable and ornamental Jodhpur (Archaean) red sandstone is a fashion in Karachi for costlier works to be used along with limestone.

TABLE I:

Physical Properties of Building Stones.

Quarry	I Ghizri (Military)	II Mauripur (Lalji Wah)	III Moach	IV Ghizri (Municipal)
Crushing strength in tons/sq. ft.	232	118	198	168
Weight in lbs./C. ft.	141.1	133.5	143.2	127.6
Porosity	9.58%	10.84%	9.93%	11.74%
General Remarks	Soft and evenly white in colour. Takes a smooth surface but gives small blocks. Has a high crushing strength.	Hard but of uneven texture. Has a low crushing strength but gives blocks of large size.	Hard but of uneven texture. Is ferruginous and dark in colour. Gives large blocks.	Hard and white. Is of even texture Takes a good polish. Also decent blocks are available.

(Data collected at the N. E. D. Engineering College).

(2) Road Metal.

The stones from the above local quarries are also used extensively as road metal. The Gaj limestones have the advantage of their having frequent outcrops directly on the spot of road repairs or construction. The necessity of transporting the material is often thus avoided. When the regular quarries are used, a fleet of lorries is employed to carry the stone where it is required.

The foundation of the roads is laid with fairly large pieces of rock, over which is placed a dressing of smaller fragments. The surface is, then, rolled and tarred. Most of the roads of the city are constructed in this manner and stand up well to the wear and tear of heavy traffic. Short sections of more recently laid roads, outside the city, are concreted but on the same foundation.

The importation of roadstone has been considered. Igneous rocks, especially trap, very suitable for the purpose, are available only from the Jodhpur and Jamnagar States. Jamnagar and Salaya, ports on the Gulf of Kutch, could be used for the transhipment of the material from this quarter. At Jasai near Balmer on the Jodhpur Railway, this rock has the characteristic columnar structure and can be easily quarried on this account.

In the construction of the Karachi—Hyderabad Railway, limestone fragments have been used as a foundation for the sleepers.

(3) Cement.

Portland cement has been manufactured since 1937 by the Dalmia Cement Ltd., at their works at Shantinagar near Drigh Road. Gaj limestones and clays are utilised from the neighbouring quarries of Bislakar and Mulri hills. Here, again, the composition of the limestones varies considerably. The clay, usually dark brown in colour, is obtained from the same quarries, as it also belongs to the Gaj series. Gypsum is imported from Jhangshai and other districts for inclusion in the cement, the local resources e.g. near Landhi, being of very small quantity. Colours in cement are produced by the use of ochre and other coloured clays from the neighbourhood of Kohistan ranges.

The output of the Dalmia factory is more than sufficient to supply Karachi's needs and, in addition, much is transported to other parts of the province. It is conveniently situated close to the port of Karachi and with good road and rail facilities at hand. One of the uses, to which the cement of this factory has been put, is the manufacture of hume pipes for the Indus Water Conduit.

The dry process of cement manufacture is followed at Drigh Road (See Plate X. A).

The colour of the cement is dark, if local limestone from the Gaj beds is used. For a better quality, limestone from the Kirthar series of rocks from other parts of Sind can be used.

TABLE II.

Chemical Analysis of Limestones (Bislakar Quarries)

$CaCO_3$	I 88%	II 86%	III 78%	IV 65%
Loss ..	39.42	38.52	35.40	30.05
CaO ..	49.88	48.13	43.17	35.44
SiO_2 plus I.R. ..	7.90	8.86	13.40	26.32
Fe_2O_3 ..	2.00	1.15	2.10	1.69
Al_2O_3 ..	1.45	2.89	6.25	5.46
MgO ..	0.49	0.37	0.40	0.84
SiO_3 ..	Trace	—	—	—
	100.14	99.92	100.72	99.44

These figures, having been obtained from specimens from the same horizon, the variation in composition of the stone is illustrated. No. IV quarry is very poor in its calcium contents.

(4) Lime.

Lime burning is undertaken in small kilns at Ghizri and near Mangho Pir. Gaj beds, again, provide the raw material. At Mangho Pir, the coral beds are quarried owing to their greater purity. The lime is utilised for mortar together with local sands, and also for concrete, again, with local sands and gravels. (See Plate X. B.).

(5) Chemicals for Industries.

The purer the limestone, the better for the chemical industries. The calcium contents of the local limestones have not reached a high percentage. Quarries, however, can be found in other formations of a better nature, and chemicals, such as $CaOCl_2$ (Bleaching powder), $CaCl_2$ and other chlorides can be manufactured from the limestone by the process of electrolysis. A better class of limestone can also be utilised for manufacturing Na_2CO_3 (Soda ash) and other compounds, so badly needed for preparing soap, glass, paper etc. Calcite crystals are obtained from Gaj limestones, embedded in their joint planes but they are are usually small.

Even the sea water can be utilised for the preparation of salts e.g. Na_2CO_3 (Soda), for industrial purposes. Chances of preparparing magnesium salts are also good.

The chemical uses of the limestone are thus restricted by the impurities, such as silica. As there is no local source of coal, heavy industries have not been developed in Karachi and thus many uses, to which the limestone might be applied, do not present themselves. If, however, a further demand occurs, the resources are considerable, except perhaps in the Ghizri quarries, which are limited in extent. Even here there remains some thousands of tons of stone. Elsewhere, however, there is an abundance of stone, though not of a very high quality.

We have seen that limestones are not so prominent in the Manchars or the local Nari rocks. The marine bands of the former series might possibly take a polish and be used as an ornamental stone. It is doubtful, however, whether there would be much demand for this for other purposes.

As the use of cement concrete increases in Karachi day by day, not only on account of the greater facilities with which building constructions are carried out but also of its safety in earthquake zones, quarrying for limestone as a building stone is getting reduced.

2. SANDSTONES, SANDS, GRAVELS AND DUST.

The Karachi area has good resources of these materials, the Nari, the Gaj and the Manchar all having sandstone beds developed in them. They are, however, generally impure. If not argillaceous, they are usually iron-stained and often soft and irregularly bedded. The Nari beds have provided a building stone from the Hab valley. This possesses a pinkish colour and is fairly hard. Care has to be taken in quarrying it, however, as it is often veined with inferior material and weathers accordingly. The sandstones, e.g. red Jhangshai sandstone, used for building construction in the city, have largely been imported. They have been utilised where large blocks are necessary and where the local limestone is unsuitable. Where special ornamental effects together with good durability have been required, stones have been imported also from the neighbouring States. Such is the case with the Municipal buildings, the Judicial Commissioner's Court building and the Kothari Pier and Parade. Here Archaean pink and red sandstones from the Jodhpur State have served the purpose, as it is excellent for both internal and external work and possesses a pleasing appearance. The cost of transportation, however, forbids its general use, which is, in any case, unnecessary, the local limestone being very satisfactory. Manchar sandstones are generally too soft and weather very rapidly.

Sands for the preparation of mortar are plentifully found in the Lyari and the Malir valleys in the alluvial deposits. The impurities make them unsuitable for the manufacture of good glass, unless some good nodules of flint are found. Some of the purest sands occur in sand dunes, as they are largely formed of quartz grains. Even here, however, mica flakes and calcite grains are present.

Alluvial gravels also provide material for concrete. Deposits occur in the Malir valley, in the neighbourhood of Landhi. The alluvium is of great importance as a water-bearing medium.

Fine sand from the Lyari river bed is used for making excellent tiles.

In an arid region, such as this, the accumulation of dust is enormous. With sand, dust is also blown by winds periodically. The particles are derived from the native rocks of limestone and sandstone and from dry muds and sand hills, the river alluvium, sea shells and sea salt. They are, therefore, of a varying size, hardness, wetness or dryness, and solubility. Those derived from $CaCO_3$ material are soft and those from SiO_2 are hard. They are carriers of germs and affect the health of the city. Except where the roads are asphalted, the dust nuisance is real.

3. CLAYS, MARLS AND SILTS.

Gaj clays, as silicates, associated with limestones of Bislakar quarries, are used by the Dalmia Works for the manufacture of cement. Local clays are used in the manufacture of bricks and tiles, although there is room for the development of the former industry. Bricks are rarely used in local buildings due to the abundance of limestone. Many of the local clays may be found satisfactory after preliminary drying and firing tests. Pottery clays are utilised at Hyderabad, Tatta and Jherruck, while Fuller's earth is obtainable near Hyderabad.

In addition to the Gaj resources, there are quite extensive clay deposits in the Manchar series.

TABLE III:

Chemical Analysis of Clays.

	I	II	III
Loss on ignition ..	12.71	11.63	9.74
SiO_2 ..	66.70	54.49	63.69
Al_2O_3 ..	12.83	10.73	21.20
Fe_2O_3 ..	5.38	8.81	3.31
CaO ..	2.11	13.13	1.34
MgO ..	0.12	Trace	0.53
Alkalis by difference. ..	0.15	1.21	0.19
	100.00	100.00	100.00

(Data collected at the N. E. D. Engineering College).

It will be seen that samples I and III are more or less similar in their calcium and silica contents and are suspected to be fire clays. The sample II differs also from the others in Fe_2O_3

and in the alkalis by difference.

4. SOILS.

True soils are scanty within our area but where a good fresh-water silt laden supply is available, the alluvium is fertile. This is the case at Malir and in parts of the Lyari valley. Elsewhere soils are frequently found to be impregnated with salt (Kalar), which can only be removed by leaching, etc. The soils are also heavy and calcareous, being provided with quantities of calcareous rain-wash from the neighbouring limestone hills. Only small areas are under cultivation, the land being mainly used for cattle grazing. Mangroves flourish in the low swampy creek regions.

The soils can be classified according to the geological foundations, upon which they rely. They are (1) residual soil derived from the underlying limestones and sandstones greatly weathered, and (2) drift soil, which occupies the dry river valleys in the neighbourhood of Karachi. The former is a calcareous and heavy variety, while the latter is fertile and rich in minerals derived from the rocks of the Kohistan area. It is also sandy in character, and periodically renewed by silt due to floods.

There is a third type of soil derived from "desert" deposits, in which sand dunes predominate and there is a regular mantle of blown sand, which prevents the growth of good soil and vegetation.

TABLE IV:
Mechanical Analysis of soil of Sind Kohistan Tract.

Fraction	Surface	Subsoil
	%	%
Clay and finest silt ..	8.89	7.84
Fine silt ..	1.70	2.12
Medium silt ..	0.39	1.76
Coarse silt ..	2.21	3.94
Fine sand ..	35.15	44.74
Coarse sand ..	51.66	39.60
	100.00	100.00
Clay portion ..	10 98	11 72
Sandy portion ..	89.02	88.28
	100.00	100.00

(D. L. Sahasrabudhe—"Soils of the Bombay Presidency (Sind)", Bom. Agr. Dept., Bull. 160.)

It can be seen that the soil derived from the Kohistan tract in Karachi and its neighbourhood is distinctly sandy. There is practically here no loam, which is so fruitful of crops in other parts of Sind.

TABLE V.

Chemical Analysis of Soil of Sind Kohistan Tract.

Fraction	Surface	Subsoil
	%	%
Moisture ..	8.38	0.54
Loss on ignition ..	3.78	4.40
Silica and insoluble silicates ..	73.90	73.31
Limes as CaO	8.18	8.01
Magnesia as MgO ..	0.50	0.50
Potash as K_2O ..	0.17	0.31
Phosphoric acid as P_2O_5 ..	0.06	0.07
Nitrogen ..	0.064	0.054
p H	8.6	8.7

(D. L. Sahasrabudhe—"Soils of the Bombay Presidency (Sind)".

The analysis reveals the tolerable alkaline nature of the soil, as pH is less than 9 and can support crops.

The lime-magnesia ratio also is 16:1, which is good and the soil is rich in P_2O_5, K_2O and CaO, while it is distinctly deficient in nitrogen which is injurious. No "liming" is needed for the soils in this region for agricultural purposes.

TABLE VI:

Chemical Analysis of typical Kalar Soil found in the Tract.

Total soluble salts ..	2.40
$CaCO_3$ ..	0.03
$CaSO_4$ ..	0.62
$MgSO_4$ ..	0.33
Na_2CO_3 ..	0.01
$NaHCO_3$ ..	Nil
Na_2SO_4 ..	0.96
NaCl ..	0.43

(V. A. Tamhane.—"Investigations into the Nature of Salt Lands in Sind", Bom. Agr. Dept., Bull. 96).

Only less harmful salts are present e.g. $CaCO_3$, $CaSO_4$ NaCl, Na_2SO_4. More harmful salts such as $MgCl_2$, $NaHCO_3$ and Na_2CO_3 are fortunately absent. Lime in the soil actually prevents the formation of sodium salts, which cause a puddling of the soil.

TABLE VII:

Analysis of Soluble Salts in the Soils found in Karachi.

Sample No.	Source	Texture	Alkalinity as Na_2CO_3
1	Artillery Maidan	Sandy loam	Nil
2	Lyari river bed	Sandy	Nil

Sample No.	Contents per 100 gms. of soil. %						
	Total Sol. salts	Ca	Mg.	SO_4''	Cl	All Cl as NaCl	CO_3''
1	0.48	0.036	Trace	0.1318	0.1264	0.2074	.01125
2	0.6	0.06	Trace	0.1769	0.1769	0.2903	.026

The above chemical analysis discloses the fact that both the types of soil have enough soluble salts to prevent decent vegetation from growing in them. The calcium and magnesium contents are, however, quite tolerable; in fact, a little more calcium would have been better. The absence of any proportion of alkalinity is also good for our purpose, but the all-chlorides, taken as NaCl, are harmful. Leaching would be the best remedy for such soils as are found in Karachi and its neighbourhood.

On the whole, the soil in the Artillery Maidan is a little better than that found in the Lyari river bed.

The geological foundation of our soils is limestone or calcareous sandstone. They are, therefore, calcareous or arenaceous and heavy. The drier parts generally give rise to salt efflorescence in soils capping Upper Tertiaries, containing connate salt water, as a result of capillary transference of them from deeper layers. Undecomposed fragments in our alluvial soils, on weathering, give rise to calcium, magnesium and sodium salts. (See Plate IX B).

Salt is also blown into the area from the sea coast and the delta of the Indus.

5. COMMON SALT.

The salt works at Mauripur were the subject of a paper by the Geological Survey in 1925. The works are situated in the low ground near the village of Mauripur, which lies west of Karachi on the borders of the Karachi 'lagoon'.

The salt is obtained from sea water which is allowed to lie on low ground at tide time and evaporate in shallow pans. These are replenished with water as required and after about twelve days the crystalline products are collected. The small concerns sell this product; but there is also a factory where a certain amount of refining is carried out. A plant for the manufacture of Epsom salts is now erected.

TABLE VIII:

Chemical Analysis of Mauripur Salt

NaCl	99.735 per cent.
$MgCl_2$	0.2647 ,,
$CaSO_4$	Trace
$MgSO_4$	Nil

A further bed occurs between Goonee and Kotri. Salt also occurs impregnated in some of the limestone and calcareous rocks and soils. Brine was noted in several limestone horizons of the Bazar and Drigh Road borings. Away from the main sub-surface stream of the Lyari, wells in the alluvium frequently give brackish water, with NaCl present up to about 300 parts per 100,000.

In addition to the Mauripur works, salt is also obtained in a similar manner from waters of the Korangi Creek in the neighbourhood of Goth Rehri near Landhi. Here the evaporating pans are located on the low marshy ground between the creek and the adjoining cliffs.

6. GYPSUM.

Gypsum occurs in the region of Goth Rehri. Only a small deposit is visible and the mineral occurs in thin lenticles, disseminated through the marl (Manchar). When required in Karachi, as in cement manufacture, it is obtained from other parts of the province. It is found in abundance in parts of the Kirthar range and also occurs in the Gaj rocks of Kohistan.

7. LIGNITE.

No coals or lignites of any extent have been observed within this area, although a small deposit of the latter is worked near Goth Rehri, a fishing village on Korangi Creek about six miles from Ibrahim Haidari. Here a soft dark-grey lignite occurs interbedded in the Manchar sandstones. About half-a-dozen shafts penetrate horizontally into the cliff face but only for a distance of about 100 ft. Some of these have been abandoned but small-scale operations continue. The mined material is put into sacks at the shaft entrances and is ready for removal.

It is possible that the bed extends inland but it is doubtful whether it does so for any great distance. This can be ascertained by a few trial pits at relatively little cost, as they need to be sunk only a few feet.

Elsewhere in Sind, brown coals sometimes occur as in the Laki Range and near Lynyan. An investigation on the lignites near Jungshai is now being carried out, but the prospects are not bright for any such fuel in the whole of the Province and most of the deposits are lenticular.

Thus, there are hardly any prospects for even the inferior Tertiary coal deposits in the whole of Sind. Of course, there can be none of the Gondwana coal in the province, as the whole region was under the sea in all the older ages.

8. IRON ORE.

Brown haematite is found embedded in limestone and sandstone in parts of Karachi district but as with the lignites, no workable deposits have been detected. The Manchar and Gaj sandstones and clays are frequently more or less ferruginous and, in the former series, small sandy ironstone nodules sometimes occur, but not in any quantity, as there is not much percolating water in this dry region and no ferruginous material above these rocks to carry it from.

9. PETROLEUM.

The nature of the rocks and the geological structure of the area renders the occurrence of petroleum a distinct possibility. Surveying in this direction has been undertaken in Sind, by oil companies. An unsuccessful experimental bore was made at Sukkur in 1893-95 and a further one by the Burma Shell Co. near

Khairpur Mirs in 1922-23, but the results are not known. Since then, investigations have been carried out in Sind Kohistan, but again with what success it is not known. In the Karachi area, however, traces of oil were noted in the Drigh Road boring. During the course of the boring operation at Drigh Road, in 1924 a smell of crude oil was noted at a depth of 720 ft. At 815 ft., the smell increased and an oily scum was seen on the surface of the issuing water, the scum emanating from a brown sandstone at this depth. Dr. H. Crookshank of the Geological Survey, subsequently visited the neighbourhood to ascertain the prospects of there being an oil reservoir near by. In reporting favourably on the prospects, he remarked that "a bore sunk near the crest of the Drigh Road dome would be a justifiable speculation". The crest of the dome was estimated as being in the vicinity of hill "253".

The presence of oil may thus be suspected from the traces occurring in the boring and on the general geological grounds viz:

(i) Oil-bearing rocks are commonly of shallow-water origin.

(iii) Brine is commonly associated with oil. This occurs at several points in the Drigh Road boring.

(iii) Sulphurous gases are associated with many petroleum sites. The water, now seeping from the sealed bore at Drigh Road, is warm and sulphuretted.

(iv) The dome structure is favourable to the formation of a reservoir.

(v) The Gaj clays would form an impermeable cover for such a reservoir.

(vi) No faulting of any importance, that might cause leakage, occurs.

The conditions thus do exist for the possibility of an oil-field. No oil seeps occur, however, nor have gas seeps, if any, been recognised. Whether further investigations have been carried out upon Dr. Crookshank's suggestions is not known but would certainly seem to be worth trying. Gas is reported to have burnt for many hours after the recent Makran earthquake and the deposits may be continuous on this side of the Hab.

10. GEOLOGICAL ASPECTS OF WATER SUPPLY.

There are chances of both surface and subterranean sources of water supply for the city, the one from the Indus river by

canalising and lifting water for long distances and the other from the dry river beds by tapping the water-logged gravel and sand and draining the fresh water into shallow wells by means of longitudinal and cross-galleries. Both the climate and the nature of rocks do not permit an open fresh-water lake to form anywhere.

(1) Water from the Indus.

The Haleji Dhand, a shallow natural salt lake, near Jungshahi, has been lately adapted to form a reservoir with a capacity of 13,000 million gallons. This is supplied, only during the innundation period, from the Indus via the Kalri Canal. The Indus pipeline then carries the water after double-pumpings to reservoirs near Karachi,—a distance of fifty miles. Any increase in supply would require the duplication of the conduits and pumping and filtering machinery, the success of which largely depends upon the construction of the Lower Sind Barrage.

Recurring problems, which influence the Indus system, include (i) the silting of the Kalri Canal, (ii) the silting of the Haleji reservoir by wind-borne material, (iii) the introduction of windblown salt into the artificial lake, (iv) the growth and decay of vegetable and animal life in the lake, (v) the seepage of impure sub-soil water into the lake as well as the pipe-line, (vi) the instability of the course of the lower Indus and the point of intake of the canal, and (vii) excessive pumping, filtration and purification processes. (See Plate XII)

(2) Water from the Malir Alluvium.

For some 65 years until the completion of the Indus pipeline in 1944, the Karachi water supply has been drawn entirely from wells sunk in the alluvium of the River Malir. The lower course of the river runs through an alluvial plain resting upon Manchar rocks in the form of a shallow syncline. Near Dumlotte, where most of the wells are situated and which lies about 30 miles from the city, the alluvium rests upon Gaj rocks but is devoid of connate salts, which have been washed off from the gravel. Fed by the more or less perennial flow of the Khadeji and also by the Mol river, the alluvium has an underground store of water, which is in slow motion. This is met at about fifty feet below the surface at Dumlotte as is the case with dry river valleys in general, but the depth decreases as the sea is approached and at Malir the level of water-table is near the surface. Lower down, at Bambo Khan Karmati, for instance, it occurs at a depth of about eight feet but here the

water is becoming brackish. Much good water runs deeper through fissures and caverns in the limestone into which the river disappears below its beds. (See Plate IX A.)

Being dependent upon the rainfall of the upper catchment basins, the subsurface water-level varies according to different periods of the year. Periodically, a season occurs where even the scanty annual average of six or seven inches of rain does not fall.

Like the dry periods, there are years in which rain falls above the average. Then the normally pure Dumlotte waters are liable to contamination. Despite these drawbacks, this local supply is to be exploited as far as possible, as the expense incurred is little compared with that of the Indus system and the water is purer. Although there is a piracy between some of the present wells, these are situated almost wholly on the right bank, the left bank being comparatively unexplored. It is a mistake to suppose that the underground flow is spread across the width of the bed or that even the maximum flow is confined to the centre. It may well be that a profitable subterranean current occurs near the left bank, which would interfere little with the existing wells. Thus the geological conditions of the Malir valley are rather intricate.

TABLE IX.

Chemical Analysis of Karachi Water (Parts per 100,000)

Source	I Haleji Raw Water **	II Dumlotte private well near Well No. 6. *	III Dumlotte Well No. 3 *	IV Haleji and Dumlotte Mixed **
Physical characters ..	Clear with suspended particles	Clear with slight sediment.	Clear with slight sediment	Clear
Free and Saline Ammonia ..	0.0032	0.0006	0.0006	0.008
Albuminiod Ammonia ..	0.014	0.0006	0.0006	0.007
Chlorides as Cl ..	17.5	33.0	44.0	14.0
Alkalinity (as $CaCO_3$) ..	9.8	17.5	26.5	16.5
Oxygen in solution at start...	0.05	0 005	nil	0.002
Oxygen in solution in 3 hrs...	0.1	0.057	0.041	0.040
Nitric Nitrogen ..	0.0367	0.032	0.026	0.05
Nitrites ..	nil	nil	nil	nil
Iron ..	0.06	0.1	0.07	0.02
Total solids ..	75.0	110.0	150.0	55.0

* (Data supplied by the Karachi Municipal Corporation).
**(Data supplied by the Chairman, Karachi Joint Water Board).

There is a great disparity in these samples of water especially in regard to the temporary and permanent hardness. But, on the whole, the Dumlotte water is far better and purer than the Haleji product.

(3) Water from the Lyari Alluvium.

Similar to the Malir sands and gravels but not so extensive is the alluvium of the River Lyari, which is also water-bearing. It is from this source that the original supply of the Old Town was drawn for several years. Villages and fields along the river course possess their own wells even now and at some places as in the tributary at Orangi, surface water occurs.

Although unlikely to yield a large and pure supply, the Lyari water is adequate for certain purposes. The Dalmia Cement Ltd. utilise it for condensers. Here a yield of about 2 lacs of gallons per day is obtained from these wells, two of which are brackish and the third fairly satisfactory, as it is near the mid-stream.

TABLE X.

Chemical Analysis of Lyari Water (Parts per 100,000)

Temporary hardness	9.24
Permanent hardness	62.32
Total hardness	71.56
Ca. hardness	47.06
Mg. hardness	24.50
Chlorides as NaCl	258.22
Total Solids	377.50

(4) Artesian Sources.

It is a fact that abundant supplies of hard water are obtained from massive sandstones or limestones if it is collected in caverns or fissures at various depths. Even in the heart of a desert, therefore, there are chances of securing a good supply of fresh water, if only it is tapped at a certain depth, as is the case in other parts of the world. "Underlying the greater part of the Lyban desert are porous sandstones and these, when pierced by deep borings put down from the lower lying floors of the depressions, yield abundant supplies of water of remarkable purity". (H. J. Llewellyn Beednell—"An Egyptian Oasis," 1909) Artesian wells dug by the Persian conquerors have already been discovered in Kharga by British geographers. (Geographical Journal, Vol. LXXX, No. 5, 1932) Fresh water has been obtained from deep artesian borings also in Gujarat and other parts of India.

Perched water-tables in folded limestone formations can be found frequently.

Let us consider the usual artesian conditions, guaranteeing flowing wells: (1) Presence of pervious beds, sandwiched between impervious beds and serving as infiltrating channels. The section of a Gaj hill, taken at Dumlotte, warrants such a state.

(2) Folded structure of beds in the form of a basin. Our rocks are tilted at low angles of dip and also thrown in gentle folds and undulations.

(3) Large catchment areas of outcropts of previous beds. Sufficiently thick and tilting beds of sandstones, conglomerates or even fractured and highly jointed limestones should serve the purpose well.

(4) Difference of level between the outcrop of pervious beds and the borehole, which is at a lower level. This is easy to secure in the Malir basin.

(5) Large caverns in underlying limestones formed by dissolution of rock by acidulated water, at times full of pure water under pressure. If even a single suitable cavern could be cut through, the whole problem of Karachi water supply can be solved. (See Plate IX A).

(6) Anticlinal valleys and synclinal hills due to the considerable fracturing of rocks and subsequent denudation of the anticlines. The latter would be better for our purpose.

The nature of the sedimentary rocks and of the synclinal folding prove the existence of artesian conditions in the Malir valley. The two trial borings, which have already been referred to, (1) at Drigh Road and (2) at the Malir-Bazar confluence, were sunk upto a depth of about 800 ft. Although an artesian flow was experienced in both the cases and some 15 ft. above the surface in the latter especially, the quantity and quality were not considered satisfactory and the bores have now been sealed. At Drigh Road, the Gaj and Uppermost Nari were pierced, while the Manchar and Gaj rocks were met with in the other boring near the Bazar River. The strata met with are represented in Plate V. Water was met with at various depths.

TABLE XI.

Cores of Drigh Road and Malir-Bazar Bores.

Drigh Road (Depth 873')			Malir-Bazar (Depth 800')		
(a) Depth	(b) Nature of Water	(c) Flow	(a) Depth	(b) Nature of water	(c) Flow
230'	Salty	—	263'=358'	Brackish (Sealed up)	
282'=312'	Brackish	300 G.P.H.	447'=455'	Tolerably potable	Total quantity of potable water was about 2 lakh gallons per day. This was increased to 5 lakhs per day with compressed air.
470'	Brackish	480 G.P.H.	493'=500'	,,	
815'=820'	Slightly oily	unknown	502'=523'	,,	
850'	—	3600 G.H.P.	552 =572'	,,	
873'	—	over 7000 G.H.P.	587'=600'	,,	
			671'=677'	,,	
			682'=699'	,,	
			752'=785'	Brackish (Sealed up)	

The following chemical analysis of a sample of water from the Malir-Bazar boring shows that the quality was not unsuitable:

TABLE XII.

Chemical Analysis of Artesian Waters (Parts per 100,000)

(Depth 600 ft. of Malir-Bazar boring and a mixture of possible flows from layers above) (30-8-1940).

Physical Character	Turbid
Free and Saline Ammonia	.110
Albuminoid Ammonia	.003
Chlorides (as Cl)	56.1
Alkalinity (as $Ca\,CO_3$)	15.1
Oxygen absorbed at start	.08
Oxygen absorbed after 3 hrs.	.17
Nitric Nitrogen	.035
Nitrites	nil
Hardness (temporary)	15.2
Hardness (permanent)	14.0
Total Solids	139.0
Iron	·001

(Data supplied by the Karachi Municipal Corporation)

Brackish water issued from the jointed limestones as connate water and was sealed up, whereas potable water came from fine sands and sandstones from which the salt was washed off, before fresh water percolated through them.

As has already been noted, it appears highly probable that the Malir-Bazar boring did not reach the necessary Nari sandstone strata. As these strata are the most likely to yield a profitable supply, being largely of sandstones of wide lateral extent, the results obtained from this bore cannot be regarded as conclusive. Had the boring been carried three or four hundred feet deeper, with a machinery capable of dealing with the loose sands which were encountered, there would have been more likelihood of success. (See Plate XI A and B)

(5) Other Possible Sources of Water.

The River Hab, the only perennial stream of the area, has been considered as another potential source of water supply for Karachi. At its nearest point it flows within twenty miles of the city, although it does not seem suitable for damming anywhere. Both the quality and quantity of the water have been so far reported as unsatisfactory.

Shallow wells sunk into the subsoil within the city limits are unsuitable as well as undesirable, as the water is generally brackish and contaminated.

TABLE XIII.
Chemical Analysis of Hab Waters.

	I Hinidan		II Saruna		III Kotiro	
	10-11-31	12-5-32	9 11-31	12-5-32	9-11-31	12-5-32
Physical Characters ..	V. hazy	Turbid	Slightly Turbid	Turbid	Hazy & suspended.	V. Turbid
Free and saline ..	0·0024	0·0026	0·200	0·008	0·0320	0 0204
Ammonia.						
Albuminoid Ammonia ..	0·0078	0·024	0·086	0·028	0·0360	0·052
Chlorides (as Cl) ..	14·10	2·3	10·6	4 7	18·0	2·3
Alkalitity (as $CaCO_3$) ..	14·50	15·5	15·0	14·7	13·0	35·0
Oxygen absorbed at start..	0 016	0 024	0·080	0·024	0·080	0·024
,, ,, in 3 hours..	0·080	0·102	0·480	0 102	0 200	0·002
Nitric nitrogen ..	0·100	0·080	0·082	0 080	0·074	0·180
Nitrites ..	Nil	Nil	Nil	Nil	0·020	Nil
Hardness (temporary) ..	14·5	4·0	15·0	4·0	13·0	6·0
,, (permanent) ..	12·0	12·0	1·5	12·0	7·0	12·0
Total solids ..	70·0	120·0	60 0	75·9	80·0	276·0
Iron ..	0·12	3·0	0·06	2·0	0·06	2·5

(Data supplied by the Karachi Municipal Corporation)

Compared to the Dumlotte supply, the waters of the Hab, taken from three localities, are not potable due to the presence of nitrites and a high proportion of total solids.

(This subject will be pursued in the Section on Water Supply in PART II.)

11. HOT SPRINGS.

The hot waters issuing at Mangho Pir have long been utilised for their medicinal effect on certain bodily ailments. The proper development of the village as a spa could act as an appreciable source of income to Karachi. In a similar manner, it might also be possible to utilise the warm sulphuretted water, now seeping from the casing of the old Drigh Road boring.

TABLE XIV.

Chemical Analysis of Hot Water of Mangho Pir.

$MgSO_4$	0·2161	grms. per litre
$CaSO_4$	0·0466	
NaCl	0·7015	
H_2S	Trace	

(Data supplied by Prof. Narwani of the D. J. Sind College)

It is to be noted that there are no sulphur deposits anywhere in Sind.

12. WIND AND WATER POWERS.

In the absence of coal or petroleum, the only chances for Karachi and Sind to secure motive power from nature are:

(1) **Wind Power.**—Wind mills can be installed in the Karachi district at convenient places and driven by the wind agency especially, when its velocity increases for some months during the year. The S.W. monsoon speed exceeds 20 miles per hour and is strong enough to carry its influence even as far as Hyderabad. Though this force is reduced in winter with the direction changed to N.E. and N.W., it is strong enough to run a rotating wind-mill, which can be used only for small industries.

(2) **Water Power.**—In a flat and dry land like the Indus valley there are no chances of natural waterfalls. There is none noticed also in the Kohistan region, except the Khadeji fall

which is, however very feeble. Investigations have also shown that there is no suitable gorge in the Hab valley for a dam e.g. at Hinidan across the river course. Although such a gorge is found at Khadeji above the confluence, the fissures and joints in the Gaj limestone will not allow a suitable catchment area.

But there is one way in which the waters of some canals can be utilised for producing power by skilful engineering. The Tando Masti Khan fall in the path of the Rohri canal affords a good chance and needs overhauling.

There are, again, some Dhands or salt lakes within the limits of Karachi district, which can be developed for this purpose. Waters can be allowed to enter such lakes through canals with their intakes from the Indus river, e.g. the Haleji lake scheme, thereby the level of the lake can be raised gradually to give it a sufficient fall on its way back to the canals, as in the case of the Aral river flowing backwards and forwards from the Manchar lake, after and before the flood season respectively.

(3) **Solar Heat.**—This can also be now utilised with advantage.

Conclusion

Thus, although Karachi is not very lucky in respect of economic minerals such as coal and iron, there are vast potentialities of developing the economic resources pointed out in this Section, if only man can help nature efficiently and constructively. If oil can also be found, as is possible in such a close neighbourhood of the city as Drigh Road, the city's future can be assured for long.

N.B.—A special Section has been devoted to the utilisation of these economic resources for gradually industrialising the Karachi City, in PART II: GEOGRAPHY, under the head of Industries.

SUMMARY

Sind is entirely a sea-born land and the rocks found in Karachi and its neighbourhood belong to the Upper Tertiary age. The oldest strata belong to the Nari series of the Oligocene system and outcrop in the range of low hills (upto 750 ft.) trending N. E. from Cape Monze to the Mangho Pir region and thence northwards. These sandstones and limestones, frequently fossiliferous, are brought to the surface at the core of the denuded. anticlinal valley, in which inlier the latter village lies near a hot spring. The Gaj series of the Middle and Lower Miocene, underneath which the Nari rocks dip, are also found in the above regions as buff-coloured sandstones and limestones, again with fossiliferous horizons, and coral beds occurring near Mangho Pir itself. Dipping under the Manchar rocks of the River Lyari valley, they reappear in an elongated dome running from the N.E. of Drigh Road to beyond Ghizri in the S.W. To the south-east, the Gaj rocks again dip under alluvium and Manchar sandstones, here in the Malir Valley. A further anticlinal fold, scarcely discernible, is found on the opposite side of the valley, but with a Manchar covering. The Pliocene and Upper Miocene rocks, mainly of the Manchar series, are largely unfossiliferous sandstones with occasional clay bands. At Ibrahim Haidari, however, two marine bands, packed with fossil fragments and sometimes bone-remains, occur. One such horizon was also noted in the outlier beyond Ghizri. Manchar sandstones occur again at Clifton, Bath Island, Oyster Islands and Manora Islands.

Capping these soft sandstones and firmly protecting them is a tough conglomerate about a dozen feet thick, containing fossils derived from older beds, probably of Pleistocene age. In addition to these solid deposits, superficial deposits are prominent in the water-bearing alluvia of the Lyari and the Malir valleys, such as, the wind-blown sands especially of the Clifton and Ghizri areas, the raised-beach deposits of Clifton and Ibrahim Haidari and the eastward expanse of creek silts and muds, eventually blending into the delta of the Indus.

The geological history of the region shows how the land owes its birth to the rising of the Extra-peninsular Mountains from the Tethys sea from the Cretaceous upto the Pliocene age, though

Sind, on the whole, was affected only by a fringe of the orogenesis. The land rose and fell and rose again, until during the Miocene age the Karachi area was occupied by a shallow gulf of the sea. Further earth movements resulted in river sedimentation of the Pliocene period. Minor fluctuations, again, produced temporary marine invasions. A general cooling of the climate heralded the Ice Age and the Post-Tertiary Conglomerate was laid down as a fluviatile depot. Even during the recent period, the general alterations of land and sea level have continued, the former gaining mastery over the latter at present. The geological history of the Indus river itself shows that a portion of its delta belonged to the old Indo-Brahm or a part of its bed is now lying submerged off the coast of Sind.

The tectonics, though very simple, help us to understand the nature of the foldings, minor faultings and slips, found in the rocks here and there. The Middle Miocene folding is shown in the Gaj rocks, while those of the late Pliocene and Pleistocene, in addition, influenced the Manchars and then the conglomerate cover respectively and resulted in an unconformity. Karachi is within the danger zone of N. India, but there are no real signs of vulcanism in its neighbourhood.

The geomorphology of the area is interesting, both the landscape and the shore-line, covering the excellent harbour, having been evolved as a result of the subaerial agencies of winds, run-off waters and the sea under semi-arid conditions. On the whole, Karachi combines the physiographic characteristics of the Kohistan region and the sea coast, its neighbouring dry river beds, its sea-front, its sand-hills, the periodic wind systems and the solar heat, all helping the shaping and reshaping of the scenery.

The economic features of the region, though not rich, are promising in regard to the future industrial growth of the city of Karachi to some extent. These are briefly narrated at the end of Part I, together with a reconsideration of the moot problem of its water supply, upon which its future largely depends.

BIBLIOGRAPHY

In chronological order of publication.

1844. H. J. Carter.

"Geological observations on the Composition of the Hills and Alluvial Soil from Hyderabad in Sind, to the Mouth of the Indus."

Journal of the Bombay Branch of the Royal Asiatic Society II—Including brief notes on the rocks and fossils of the area mentioned.

1840. Capt. N. Vicary.

"Note on the Geological Structure of parts of Sind."

Quarterly Journal of the Geological Society of London, 1874. Vol. III.

The first important work on the geology of Sind. Capt. Vicary travelled from Karachi to Sukkur in 1845 and recorded his observations in the above paper. He obtained a remarkably clear idea of the relations of the rocks that he encountered but was misled by the inaccurate maps of the period.

1849. H. J. Carter

"On Forminifera, their Organisation and their Existence in a Fossilised State in Arabia, Sindh, Kutch and Kathyawar."

J. B. Br. Roy. As. Soc., III, Part I.

1850. C. F. Collier.

"On the Nature of the Soils of the Bombay Presidency." Trans. Bombay Geog. Soc., Vol. 9.

Brief mention is made of the rocks noted on a journey from Hyderabad to Karachi via Tatta.

1852. Dr. Buist.

"The Volcanoes of India."

Trans. Bom. Geog. Soc., Vol. 10.

Dr. Buist mistakenly refers to a volcanic crater in the neighbourhood of Mangho Pir, perhaps due to the crater-like hollow in the anticlinal folds.

1853. Sir Bartle Frere.

"On the Geology of a part of Sind."

Q.J.G.S. 1853 Vol. IX.

Refers to the rocks and fossils of the hills south-west of Sehwan and Manchar Lake, also of the Karachi Sehwan Road. The author was intimately connected with the development of Karachi.

H. J. Carter.

(i) "Destruction of some of the larger forms of Fossilised Foraminifera in Sind with observations on their Internal Structure."

J. B. Br. Roy. As. Soc. III.

(ii) "Note on the Pliocene deposits of the shores of the Arabian Sea". J. B. Br. Roy. As. Soc. IV.

Reference is made to some of the strata in the neighbourhood of Karachi Harbour.

D'Archiac and Haine.

"Description des Animaux Fossiles du Groupe Nummulitique de l' Inde," Paris 1853.

One part of this important work is devoted to Cutch, Sind and a portion of Baluchistan.

1857. H. J. Carter.

(i) "Summary of the Geology of India between the Ganges Indus and Cape Comorin."

This work includes

(ii) "Contributions to the Geology of Central and Western India". J.B.Br. Roy. As. Soc. V.

The information which refers to the rocks of Western Sind mainly repeats that of the author's earlier works.

1861. (iii) "Further Observations on the Structure of Foraminifera and on the larger Fossilised forms of Sind."

J. B. Br. Roy. As. Soc. VI.

Also Annals and Magazine, Natural History, Ser. 5 Vol. 8.

(IV) "Contributions to the Geology of Western India, including Sind and Beloochistan" (2nd series).

J. B. Br. Roy. As. Soc. VI.

This work includes a note on the coal deposits in the Lynean valley, also that of Lainyan.

1864. H. M. Jenkins.

"On some Tertiary Mollusca from Mount Sela, in the Island of Java" Q.J.G.S. XX.

It was suggested here that some of the Sind fossils were more recent than Eocene, as were the similar Javanese specimens.

P. Martin-Duncan.

"Descriptions of Sind Corals."

Annals and Magazine of Natural History, April 1864 (Ser. 3, XIII).

Professor Martin Duncan confirmed the views of H. M. Jenkins. Several of the corals described were obtained from the Karachi district.

1865. J. Lalor.

"A Report on Dhur Garoo, in the Shikarpur Collectorate."

Trans. Bom. Geog. Soc. Vol. XVII.

A note on the rocks of the Kirthar Range is included.

1866. J. Evans.

"Description of Some Flint Cores obtained in the Bed of the Indus."

Geol. Mag. 1866 Vol. III.

1867. General Twemlow.

"Further remarks on the above subject with a section of the Indus near Sukkur."

W. T. Blanford.

"On the Geology of the Neighbourhood of Lynean and Raneekote"

Memoirs of the Geological Survey of India Vol. VI. Pt. I. 1867.

Containing the observations made during a visit to Kotri, Lainyan and Ranikot in order to investigate the prospects of additional coal deposits.

J. W. Barnes.

"Subterranean Supply of Water (Karachi.)"

Bombay P.W.D.

Also Jour. Roy. Geog. Soc. 1867.

1872. "The Coasts of Baluchistan and Persia, from Karachi to the Head of the Persian Gulf and some of the gulf islands."

Records of the Geological Survey of India Vol. V. Pt. 2.

1876. W. T. Blanford.

(1) "The Geology of Sind." First Notice R.G.S.I. Vol. IX Pt. 1.

(ii) "The Geology of Sind." Second notice R.G.S.I. Vol. XI. Pt. II.

Notices of the principal results of the survey of western Sind.

1879. (iii) "The Geology of Western Sind."

M.G.S.I., Vol. XVII, Pt 1

This work still remains the standard reference to the geology of the province.

F. Fedden.

"On the distribution of the fossils described by Messrs. D'Archiac and Haine in the different Tertiary and Infra-Tertiary groups of Sind." M.G.S.I. Vol. XVII Pt. I. P. 197.

1871. F. Stoliazka, W. T. Blanford, W. Percey Sladen and P. Martin-Duncan.

"The Tertiary and Upper Cretaceous Fauna of Western India."

Palaeontologia Indica Ser. VII, XIV.

Including monographs on fossil crabs, corals, alcyonaria and echinoids.

1879. W. T. Blanford and H. B. Medlicott.

"A Manual of the Geology of India."

Geological Survey of India.

Containing a general account of the geology of Sind, based on Blanford's 1879 Memoir.

1880. J. A. Murray.

"Geology, Botany and Zoology of Sind."

A pioneer work, but requiring improvements.

1895. "Experimental boring for petroleum at Sukkur 1893-1895." R.G.S.I. Vol. XXVII, Part 2.

Report is not known.

1901. R. D. Oldham.

"The Sandhills of Clifton, near Karachi."

M.G.S.I. Vol. XXXIV, pt. 3.

Dealing with the origin and possible methods of control of these sandhills.

1904. E. Suess.

"The face of the Earth" (Trans. H.B.C. Sollas).

The structure of Sind n relation to neighbouring areas is referred to in this classic work.

1906. M. Cossmann and G. Pissarro.

"Classification of the Tertiary System in Sind with reference to the Zonal Distribution of Eocene Echinoidea."

R.G.S.I. XXXIV Part 3.

"Breynia multi-tubereulata from the Nari of Baluchistan and Sind."

R.G.S.I. XXXIV Part 4

1907. E. H. Aitkin.

"Gazetteer of the Province of Sind".

This gazetteer contains brief references to the geology of the province.

1909. E. Vrendenburg.

"Tertiary and Post-Tertiary Freshwater Deposits of Baluchistan and Sind."

R.G.S.I. Vol. XXXVII Pt. 2.

Contains a valuable map of the area.

M. Cossmann and G. Pissarro.

"The Mollusca of the Ranikot Series."

Pal. S. Ind. Vol. III. Mem. No. 1.

A. Hill.

"Erosion and deposition of the Indus."

Geol. Mag. VII.

1910. "Revised classification of the Tertiary freshwater deposits of India."

R.G.S.I. Vol. XL. Pt. 3.

1914. M. Lea.

"Report on the building and roadstones available to Karachi." (Unpublished.)

1923. G. de P. Cotter.

"Alkaline Lakes and the Soda Industry of Sind."

M.G.S.I. Vol. XLVII Pt. 2.

Analyses of kharo chaniho etc.

M. Webb.

"Karachi Handbook and Directory."

Including histories of the Keamari Harbour and Karachi Water Supply.

1925. E. W. Vredenburg.

"Descriptions of the Mollusca from the Post-Eocene Tertiary formation of N.W. India".

M.G.S.I., Vol. L, Pt. I, and Pt. II, 1928.

"Report on the Malir Boring Investigation for the Karachi Water Supply'.

Bombay P.W.D. Technical Paper No. 11.

Gives some valuable hydraulic data.

"Mauripur Salt Works".

R.G.S.I., Vol. LVI, Pt. 4.

A chemical analysis is given in the body of this Part.

1926 D. N. Wadia.

The Geology of India (1st Edn.), MacMillan.

Contains an excellent summary of the Tertiary and Post-Tertiary rocks.

1927 H. Crookshank.

Oil Indications at Drigh Road, near Karachi.

R.G.S.I., Vol. LX, Pt. 2.

The contents of this paper have been referred to on several occasions within the present work.

M. Cossmann and G. Pissarro,

The Mollusca of the Ranikot series.

Pal. Ind. Vol. X, Mem. II.

E. Vredenbeurg. "The Mollusca of the Ranikot Series". Pal. Ind. Vol. X Mem. No. 2. Revised from the work of M. Crossmann and G. Pisarro.

1928. E. W. Vredenburg.

(i) "A Supplement to the Mollusca of the Ranikot Series". Pal. Ind. Vol. V, Mem. 4 Edited by G. de P. Cotter.

(ii) "Descriptions of the Mollusca from the Post-Eocene Tertiary Formation of N.W. India."

M.G.S.I. Vol. I, Pt. 2.

Containing descriptions of species, some from the Karachi District.

1929. H. Douville.

"Les Couches a Cardita Beaumonti Clans le Sind".

Pal. Ind., Vol. X, Mem.3, Fasc. II.

1932 C. G. Hawes

"A note on the sub soil investigations made in the area commanded by the Lloyd Barrage Canals".

Paper 136, Bom., Eng., Cong. Contains references to Kalar Soils.

1934. W. D. West.

"The Baluchistan Earthquake of August 25th and 27th 1931". M.G.S.I., Vol. LXVIII, Pt. I.

1935. W. D. West.

"Preliminary Geological Report on the Baluchistan (Quetta) Earthquake of May 31st 1935". R.G.S.I. Vol. LXIX, Pt. 2.

Indications are clear that Karachi is within the Danger Zone.

1936 Maneck B. Pithawalla.

(i) "A Geographical Analysis of the Lower Indus Basin". Proc. Ind. Aca. Sci. B. IV, 4.

A comprehensive account of the geography of Sind with a summary of the geology of the province.

(ii) "Karachi Water Supply".

The Young Engineer, Karachi.

Pleads for an artesian supply.

1937. D. A. Howell.

"Report on the Water Supply of the City of Karachi".

1938 Maneck B. Pithawalla,

(i) "The Potential Spas of Sind". The Young Eng. Notes on the springs in Sind and their possible exploitations.

(ii) "Settlements in the Lower Indus Basin" (Sind): Part I: Dealing with Climatic, Geomorphological, Tectotonic and Hydrographic changes in the Region. Jour. Madras Geog. Assn. XIII, 4.

D. N. Wadia.

"Geology of India" (2nd Edn.), MacMillan.

1940 M. S. Krishnan and N. K. N. Aiyengar.

"Did the Indobrahm or Sivalik River exist?"

R.G.S.I. Vol. LXXV, Prof. Paper No. 6.

A very doubtful thesis.

1942 Maneck B. Pithawalla.

(i) "Our Water Problem: A plea for the Malir Sources". "Daily Gazette", Karachi, 1st March.

1943. (ii) "The Physics of the Indus and its Relation to the Floods in Sind".

Sci. and Cul. Vol. IX.

M. S. Krishnan.

"The Geology of India and Burma", Madras.

A revision of the classification of Tertiary Rocks is found in this volume. The Laki series is scrapped.

1945 Maneck B. Pithawalla.

"The Earthquake of 28-11-1945". The Young Engineer, Karachi.

Confirms the fact that Karachi is within the Danger Zone.

DESCRIPTION OF PLATES

PLATE No.

I A. Geological Map of Karachi and its Neighbourhood.

B. Geological Section across Karachi and Its Neighbourhood (along A. B. C. D.).

II. Plans showing:

A. Positions of Gaj Deposits at Ghizri.

B. Positions of Manchar Deposits near Ibrahim Haidari Ridge.

N. B. The numbers indicate the localities at which vertical sections have been taken.

III. Vertical Sections showing:

A. Gaj Deposits near Ghizri (Nos. 1 to 4).

B. Manchar Deposits at Ibrahim Haidari Ridge (Nos. 1 to 9).

IV. Vertical Sections Showin :

A. Manchar Deposits near Ibrahim Haidari Ridge (Nos. 10 to 17).

B. Manchar Deposits and Post-Tertiary Conglomerate (Nos. 18 to 22).

V. Vertical Sections showing

A. Deep Bore at Drigh R ad.

B. Deep Bore at the Junction of the Bazar and the Malir Rivers.

VI. Diagrams showing:

Geological History of the Earth within the area of Karachi and Its Neighbourhood. (Stages I to VII).

VII. Photographs Nos 1 to 8:

1. Micro-photograph showing wind-blown sand at Ghizri. Rounding of the grains has just started. Darker colour shows calcium carbonate grains and lighter ones silica grains.

2. Gulley in the Hab alluvium with Nari outcrops in the distance.

3. Gaj outcrop at Orangi, 6 miles north of Karachi. The dip slope of the ridge, which is visible, is quarried for building stone and road metal.

4. Gaj outcrop at Orangi. A calcarious sandstone outcropping where the Mangho Pir road cuts the Orangi Nadi.

5. Shallow lake by the roadside on the way to the Hab river, about 10 miles from Karachi. The Gaj hills leading to Cape Monze are in the background. Small Gaj outcrops occur near this lake.

6. Inclined Manchar sandstones, overlain by the Lyari alluvial gravel in the dry bed of the Orangi Nadi.

7. Gulley in Manchar gypseous marls near Landhi.

8. Manchar outcrop S.W. end of the Ibrahim Haidari ridge. One of the marine bands can be seen forming the outstanding bed.

The Ghizri—Malir plain lies beyond.

VIII. Photographs Nos. 9 to 16:

9. Another view of the Ibrahim Haidari Ridge. The conglomerate caps the hill and the first marine band forms the lower shelf.

10. Manchar sandstones in the cliffs between Ibrahim Haidari and Landhi.

11. Fallen blocks of the capping Post-Tertiary conglomerate along the cliffs between Ibrahim Haidari and Landhi.

12. The Hab river and the valley. The rocks at the stream centre are Post-Tertiary conglomerates. The view is taken from the Sind side. The foot-hills of the Baluchistan—Pabb Range lie in the distance.

13. Raised-beach deposits on the S.W. end of the Ibrahim Haidari Ridge. Height of deposits shown here is about 60 ft. above sea level.

14. Raised-shell banks (oysters) shown in the foreground. Height above sea level about 10 ft. At Hawkes Bay 14 miles W. of Karachi on the shore of the Arabian Sea.

15. The mangrove swamps of the creek region near Landhi. The scale may be taken from the height of the man in the foreground.

16. A crescent-shaped sand-hill near Korangi Creek Camp.

IX. Photographs Nos. 17 to 20.

17. Irregular rippling on wind-blown sand near Korangi Creek Camp.

18. Wind-blown sand piled up against Manchar rocks at Clifton.

19. Shore of Korangi from Landhi towards Ibrahim Haidari.

20. Wind-blown sand deposits between Ghizri Creek and Ibrahim Haidari Ridge.

A. Cross Section showing:

Underground Flow of Water in the Malir River Valley.

B. Section showing:

Soil and Sub-soil at Sadar.

X. A. Diagram showing:

Dry Process of Cement Manufacture at Drigh Road.

B. Diagram showing:

Country Lime Kiln at Ghizri.

XI. Plans and Sections showing:

Malir-Dumlotte Water Supply System.

A. Two Sections in Karachi District:

1. Section across Mango Pir.
2. Section 25 miles north of Karachi.

B. Geological Formations around Malir River near Wells 1 and 2.

C. Geological Section along A-B.

XII. Photographs Nos. 1 to 9 showing:
Indus Water Supply Scheme:

1. Haleji Intake Tower.
2. Haleji Regulator.
3. Masonry Conduit.
4. Manhole.
5. Manufacture of Hume Pipe.
6. Completed Hume Pipe
7. Collar Joint in Hume Pipe.
8. Pump House.
9. Coagulation Tank.

END OF

PART I: GEOLOGY

Printed by K. K. SOPARIVALA at the "Sind Observer" Press Ltd., McLeod Road, Karachi, and published by Prof. Maneck B. Pithawalla, Katrak Building, Victoria Road, Karachi.

PLATE III. (A)

VERTICAL SECTIONS OF GAJ DEPOSITS NEAR GHIZRI

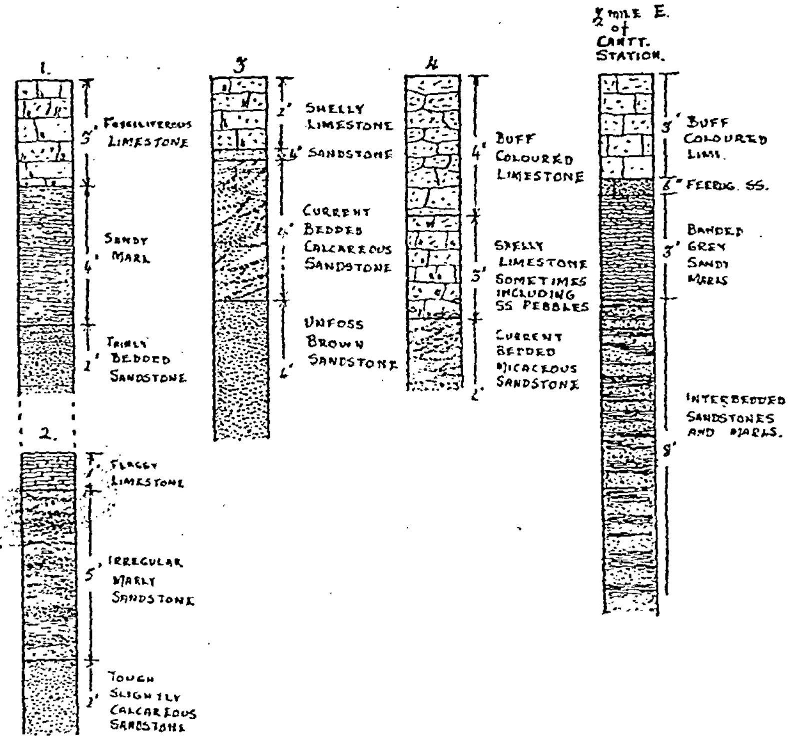


PLATE III. (B)

VERTICAL SECTIONS OF MANCHAR DEPOSITS NEAR IBRAHIM HAIDARI

One Inch Represents 10 Feet. For location of these sections see sketch map.

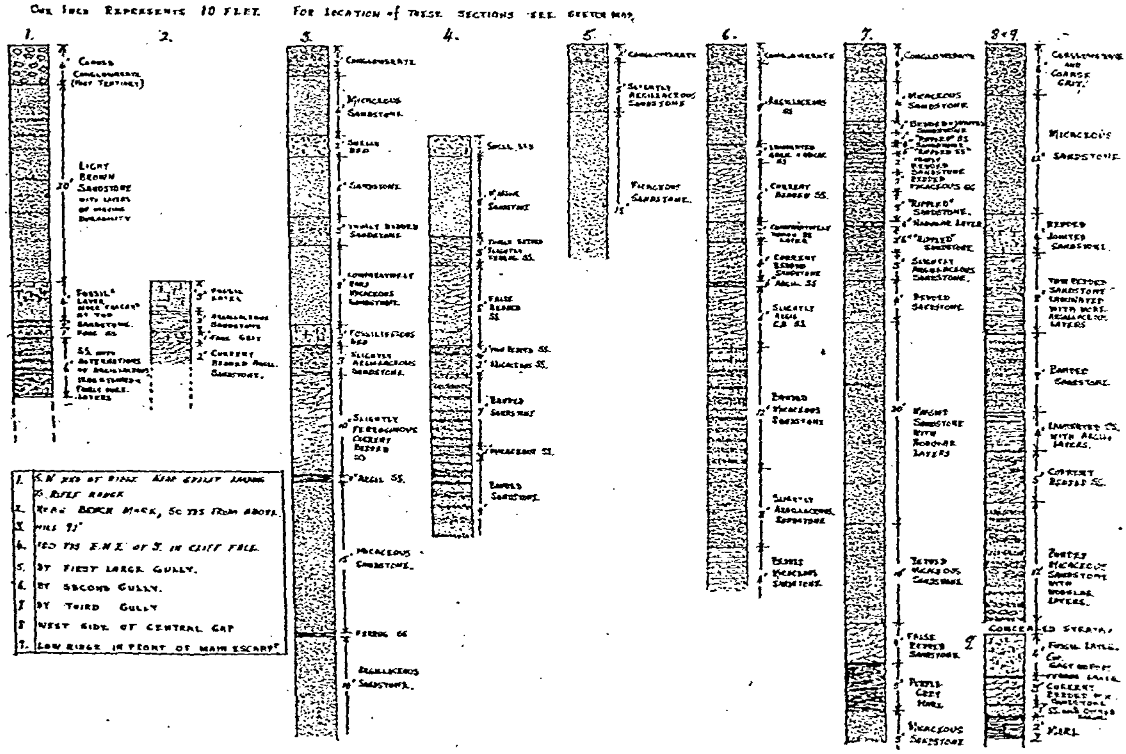
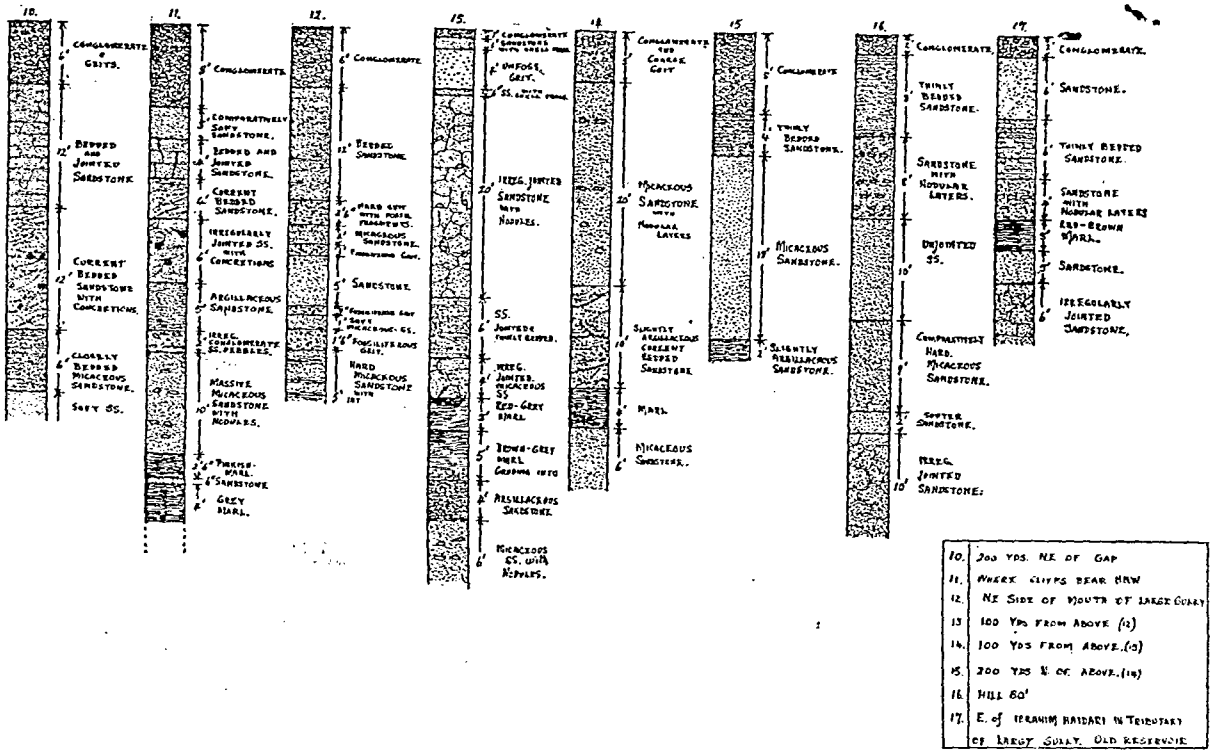


PLATE IV. (A)

VERTICAL SECTIONS OF MANCHAR DEPOSITS NEAR IBRAHIM HAIDARI (CONT:)



10.	300 YDS. NE OF GAP
11.	WEEK CLIFFS NEAR HRW
12.	NE SIDE OF MOUTH OF LARGE GULLY
13.	100 YDS FROM ABOVE (12)
14.	100 YDS FROM ABOVE (13)
15.	200 YDS N OF ABOVE (14)
16.	HILL 80'
17.	E. of IBRAHIM HAIDARI IN TRIBUTARY OF LARGE GULLY. OLD RESERVOIR

PLATE IV. (B)

VERTICAL SECTIONS OF MANCHAR AND POST-TERTIARY CONGLOMERATE DEPOSITS.

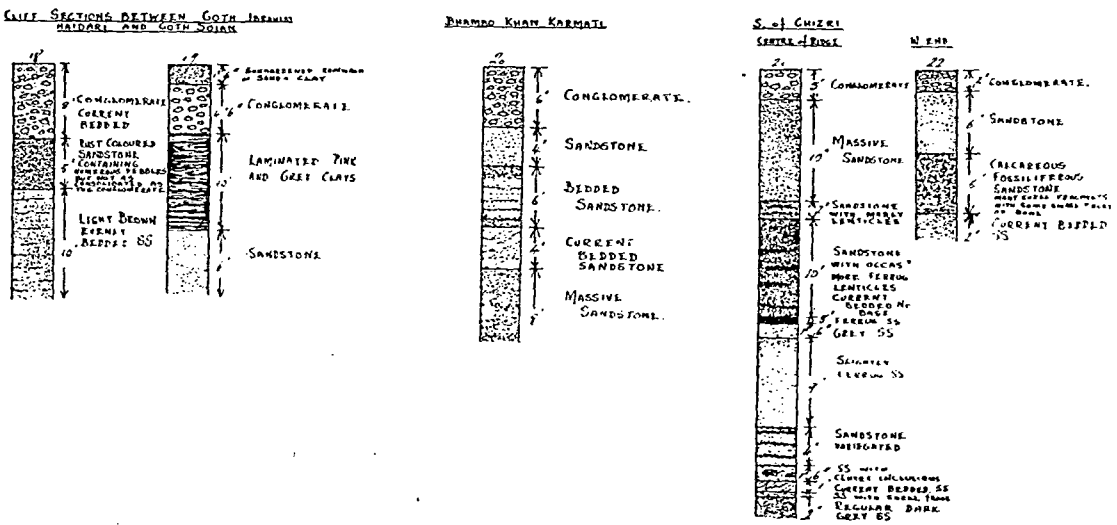
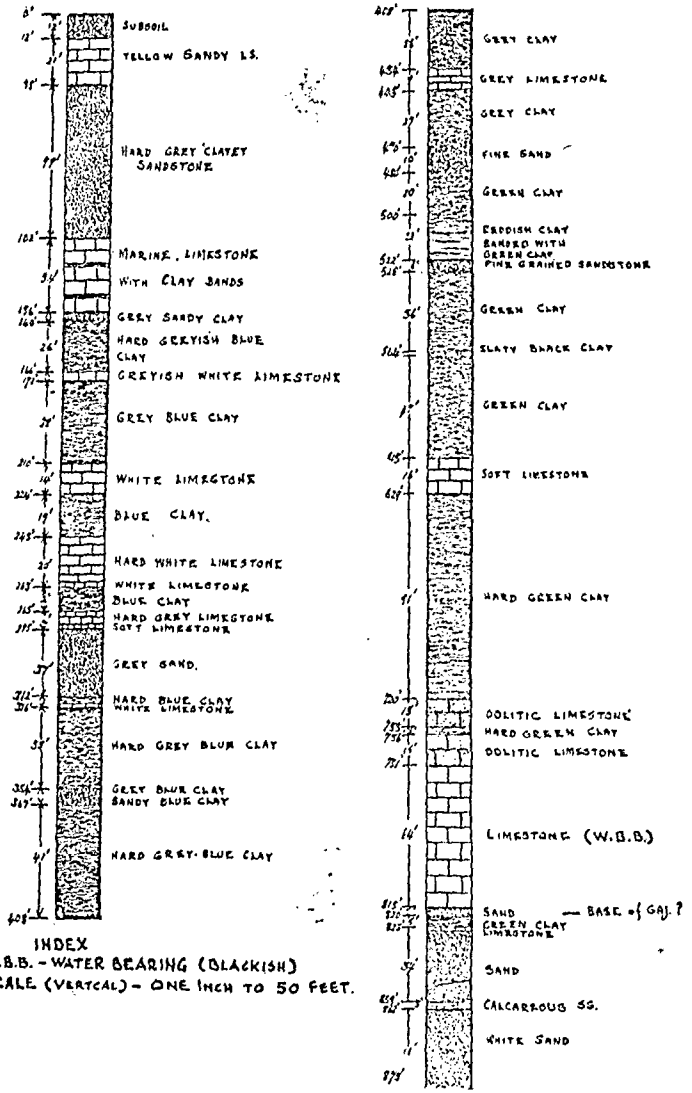


PLATE V. (A)

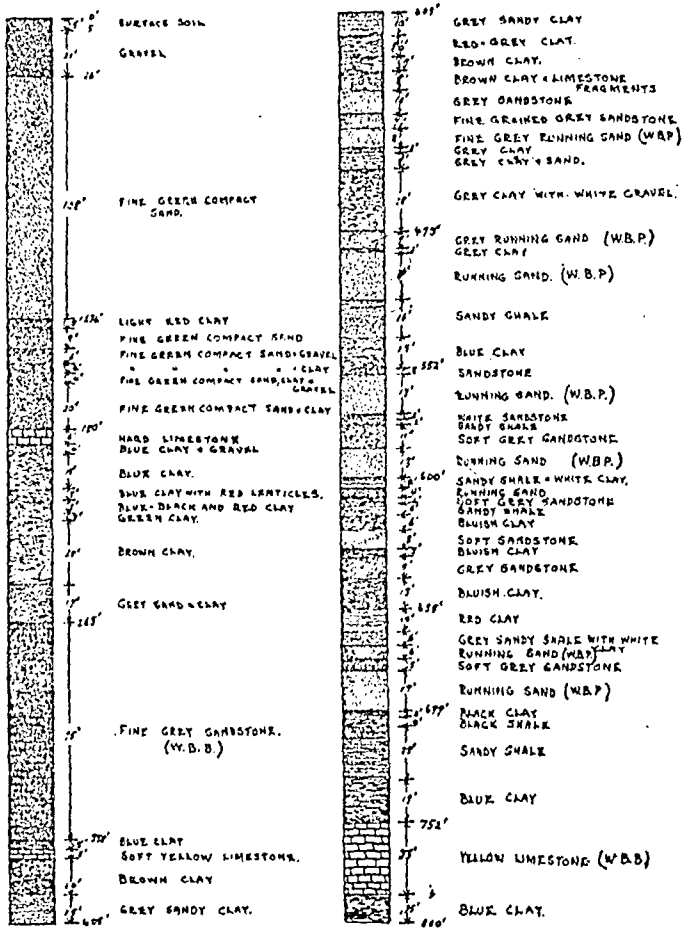
SECTION OF BORE AT DRIGH ROAD, KARACHI



INDEX
W.B.B. - WATER BEARING (BLACKISH)
SCALE (VERTCAL) - ONE INCH TO 50 FEET.

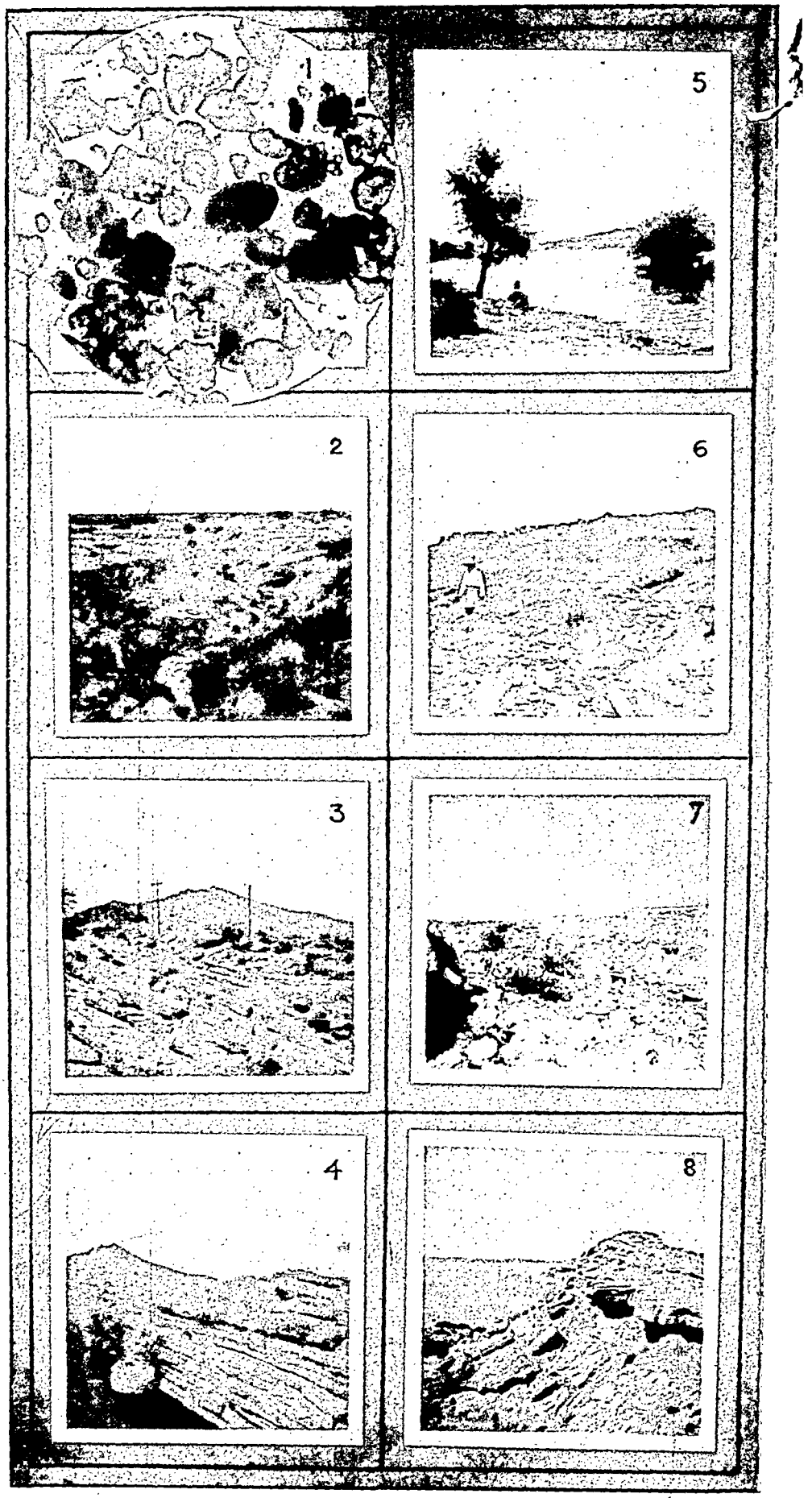
PLATE V. (B)

SECTION OF BORE NEAR THE CONFLUENCE OF THE BAZAR AND MALIR RIVERS.



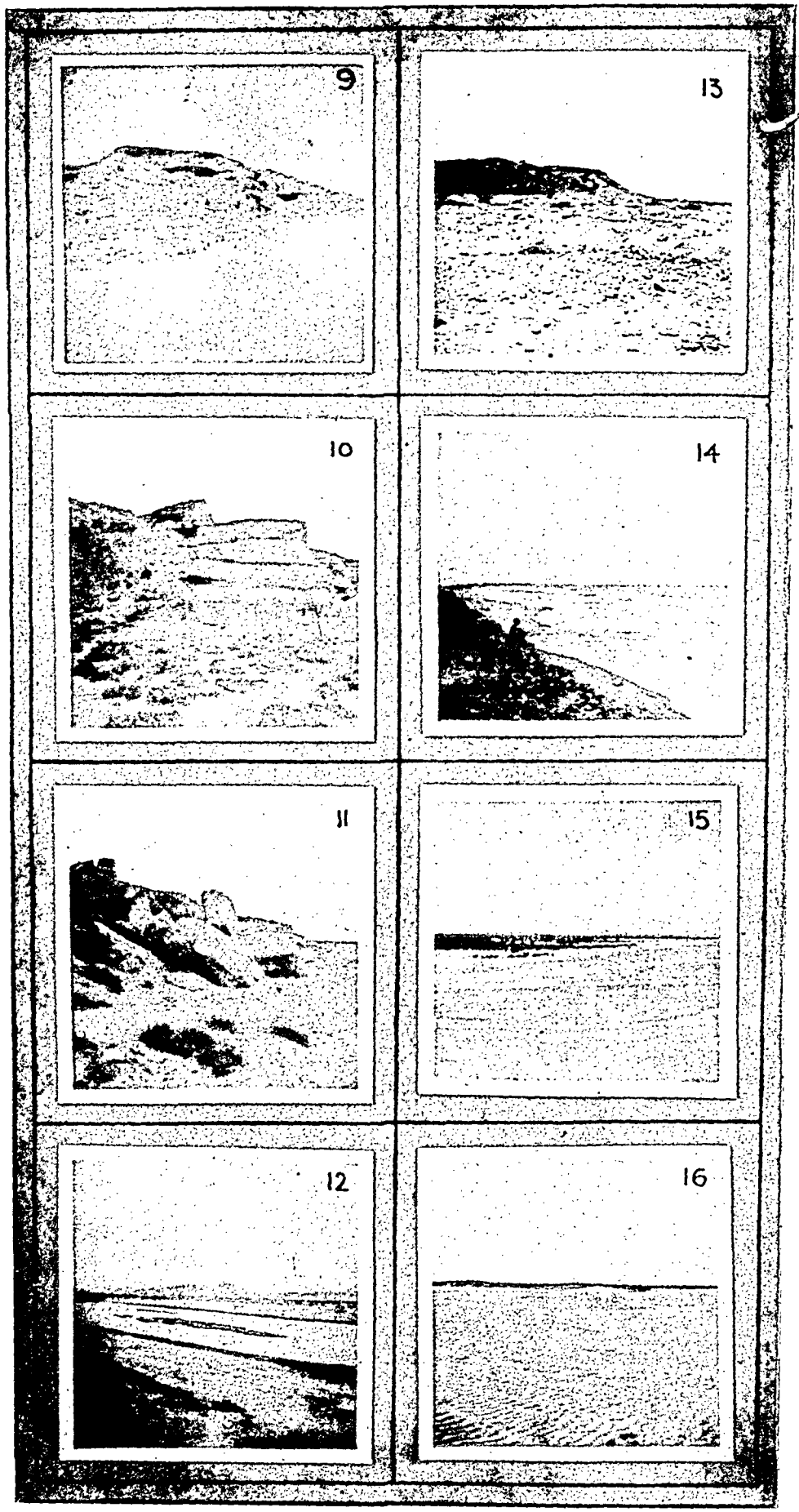
VERTICAL SCALE - ONE INCH TO FIFTY FEET.
W.B.B. WATER BEARING (BRACKISH)
W.B.P. WATER BEARING (POTABLE)

PLATE VII



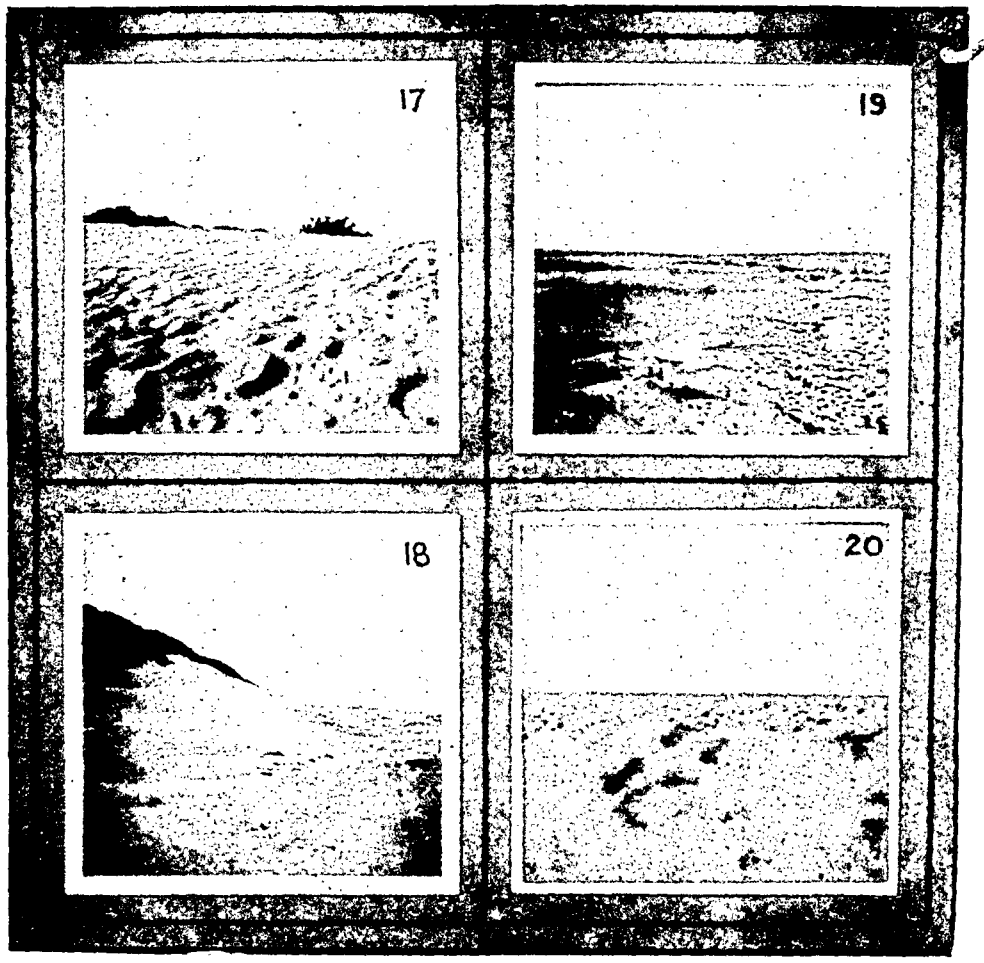
CHITRA-KALA PRESS, KARACHI.

PLATE VIII.



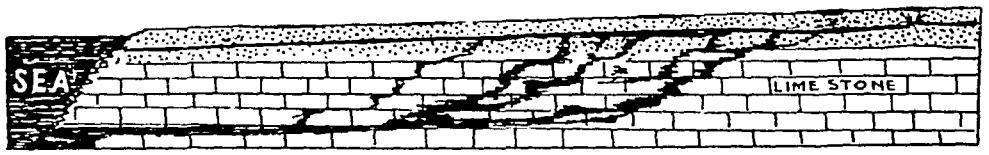
CHITRA-KALA PRESS, KARACHI.

PLATE IX



A.

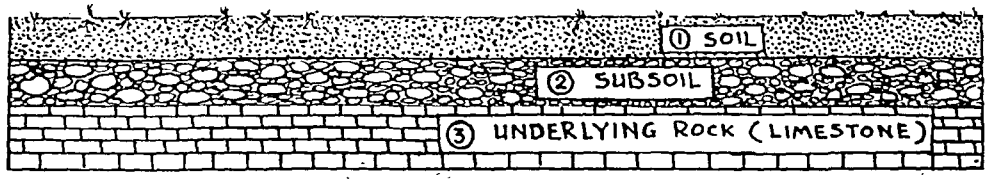
CROSS SECTION SHOWING UNDERGROUND FLOW OF WATER IN THE MALIR RIVER VALLEY



S.B. KULKARNI

B.

SECTION SHOWING SOIL AND SUBSOIL AT SADAR



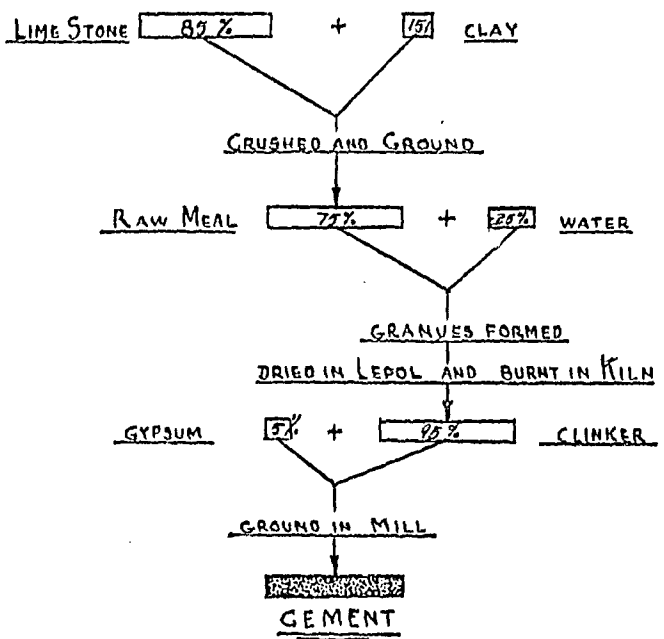
S.B. KULKARNI

CHITRA-KALA PRESS, KARACHI.

PLATE X.

A.

DIAGRAM SHOWING
DRY PROCESS OF CEMENT MANUFACTURE
AT DRIGH ROAD



B.

DIAGRAM SHOWING
COUNTRY LIME KILN
AT GHIZRI

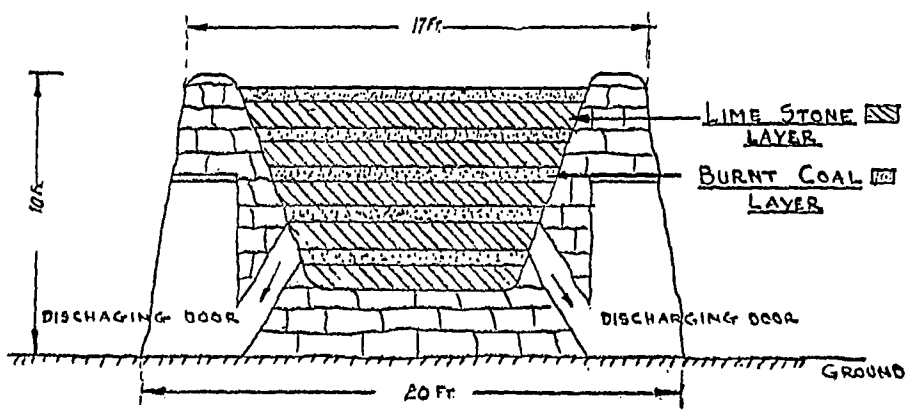
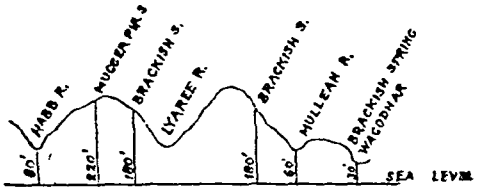


PLATE XI.



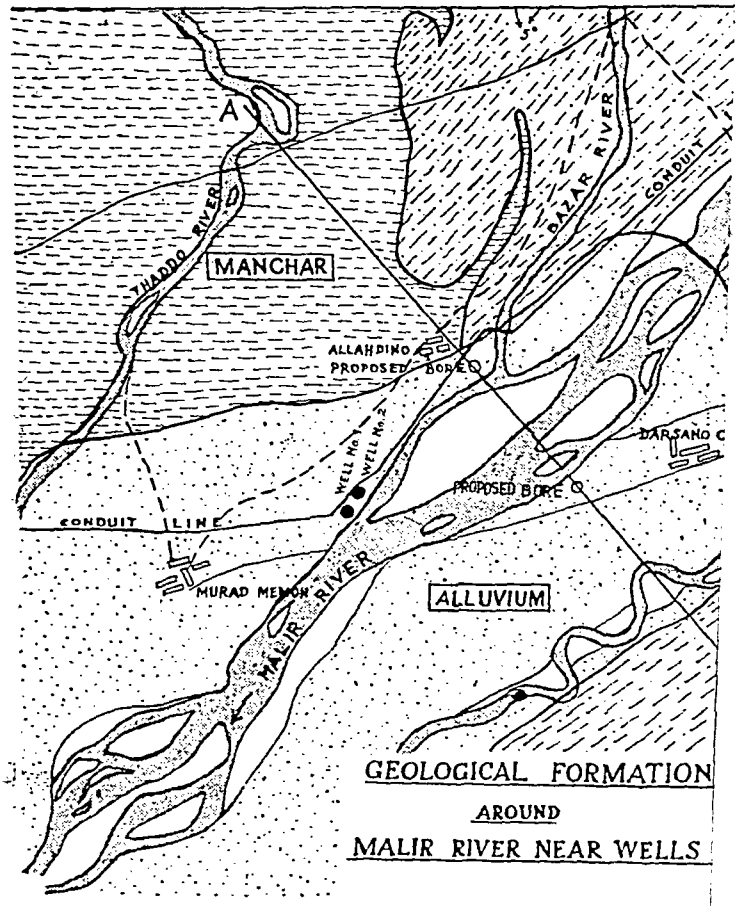
SECTION ACROSS MUGGER PIR

TWO SECTIONS

KARACHI DISTRI

4 MILES

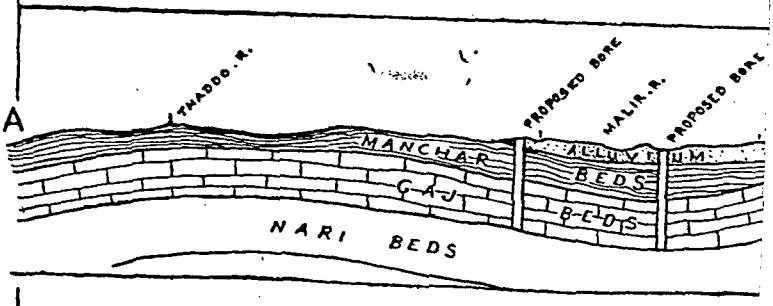
(J.W. B



GEOLOGICAL FORMATION

AROUND

MALIR RIVER NEAR WELLS



SECTION ON A B

HOR. = 1 MILE

VER. = 1000 FT

PART II. GEOGRAPHY

CONTENTS OF PART II.

PAGE

PAGE

PART II :—GEOGRAPHY

PRELIMINARY NOTE

If there is any city in India that has grown extraordinarily within the brief period of a century and risen to be the 3rd Sea Port and the 1st Air Port of India, the new Capital of an age-old though long forgotten province and a most important centre in the Middle East for international trade, it is Karachi. Much of its greatness the city owes to its geography. Like the Tertiary rocks on which it is founded, it is, indeed, a Tertiary city growth in our country, which is so rich in its ancient and mediaeval cities. Even Hyderabad, the erstwhile capital of Sind, was not a city till the last census time, when its population could reach the figure of 100,000. Karachi was a mere fishing village and a very insignificant Hindu colony even before the advent of the British in 1843. The Karachi of Bhojoomal and Naoomal was "a town of low mud hovels and tall mud houses with flat mud roofs, windowless mud walls and numerous mud ventilations, surrounded by a tumbled-down parapet of mud, built upon a platform of mud-covered rock and dark narrow alleys, through which nothing bulkier than a jackal can pass with ease, drainage managed by evaporation and birds and dogs the only scavangers."

Today the city covers more than 7 square miles of open land and boasts of thousands of palatial buildings, public and private, a first-class harbour, some excellent motorable roads and vast open spaces for the rich colonies, belonging to the different communities, which have given their valuable share in its extension and development.

And all this in a region, which has proved to be a most unstable one from the point of view of human settlement. There is not a single living city in Sind that has come to our heritage from olden times, Mohenjo Daro including. No doubt there were other small ports on the Sind coast, which is, really speaking, extremely uninviting due to the ever growing Indus delta, but they have vanished with the changing hydrography of the river. They have come and gone, though the mighty river has, on the other hand, made Sind what it is today,—a fertile and prosperous land. Besides, Sind is a province almost entirely

made of villages and small towns. It is noteworthy, therefore, that Karachi is gaining at a time when the tendency for urbanisation is really losing strength in Sind.

For many centuries the search for a permanent sea port for Sind continued, the people preferring to settle at the mouth of one of the branches of the Indus. When that was not possible, they sought the mouths of other rivers flowing into the Arabian Sea, e.g. Kharak Bandar on the gulf of Oman at the mouth of the Hab and Sonmiani at the mouth of the Windar some 50 miles towards the west of Karachi, until at last the way was opened for the establishment of our city. The Manora rock and the natural water channel between it and the Keamari island have given the port that stability for which the people craved for centuries in other places on the coast.

The time factor and the man factor completed the work of the establishment of Karachi, when the British took possession of the Indus valley as a prelude to the conquest of the Punjab and Afghanistan. These sea-faring people readily preferred the Karachi harbour to the old inland capital town of Hyderabad after the battles of Miani and Daba in 1843.

It cannot be denied that Karachi is a gift of the British to Sind. These foreigners soon realised the importance of the partially natural harbour and endeavoured to improve it artificially, so much so that when Sir Charles Napier, the founder of Karachi, left the shore of Sind, he uttered these words, "You will yet be a glory of the East, would that I could come again to see you Kurrachee in your grandeur!" The time has now come when Karachi will certainly prove to be "a glory of the East," so fast is it progressing due to its favourable geographical circumstances, provided a suitable plan is made for its future development.

Thus the first people to take advantage of its natural facilities were the British, who soon put it on the commercial map of the world.

The natives also followed suit, as they found no other safe outlet for trade on the Sind Coast for both the Upper (The Punjab) and the lower (Sind) Indus valleys. The peoples from neighbouring provinces also came along the old lines of communication established on land and sea. As the land was fertile

and easy to occupy, they stayed long enough and flourished in it, till the world began to take advantage of the facilities of the port which actually lay at the apex of the Indian Ocean and on the way to the Persian Gulf and the Suez Canal.

With all this, Karachi is still in the making. Both the World Wars have stimulated its growth and advancement as a triple port, land, sea and air. The utilisation of the land in the neighbourhood of the city has lately been rapid and attempts have also been made to improve the water supply, the chief obstruction in its growth. But the greatest success of Karachi is in its status as an airport. "Where once camels roamed and kites hovered undisturbed over mud and sand wastes of Sind Desert's Coastal Strip, is now the busiest airport in the world. Karachi, ancient gateway to India from the Arabian Sea, is now on the crossroads of the skies. The hundreds of tar-macadam acres of its three aerodromes and the sheltered water of a dockland creek hourly carpet the arrival and departure of land and sea planes flying to the four corners of the earth." Here, again, the east meets the west with infinite advantages to both. Thus Alexander's utmost eastern limit of conquest has turned into one of the biggest air centres of the world after these 22 centuries and more, and the geographical value of Karachi has been enhanced.

Not that there were no mistakes made in its planning. Although the credit of the discovery of a permanent source of water supply for Karachi in the Malir valley is given to Captain De Lisle in 1856, the whole area was not properly and geologically surveyed and wells were sunk haphazardly on one bank of the river only. Quite a number of reports and papers have been published (see the Bibliography) on this subject by experts since then and even today the problem cannot be said to have been permanently solved. Similarly the drainage lines were laid defectively all throughout the city, which has, therefore, suffered much in sanitation and public health in recent years after its phenomenal growth of population. Town planning has been neglected in some parts. As lands were available plentifully on all sides, the congestion in the Old Town and other neighbouring quarters is unpardonable in an otherwise healthy city.

That so splendid a city should have such little literature published on other important aspects of it, is surprising. The

earliest record on the Sind region is found in the "Voyage of Nearchus from the Indus to the Euphrates" by W. Vincent in 1797. But it is not certain whether the Karachi harbour was actually touched by Nearchus, though it was styled as Alexander's Haven. A plan of the harbour was, however, made some 23 years earlier by Mascall in 1774. Hardly half a dozen books have been published during the whole of the 19th century on the harbour and the town, inspite of their attraction and importance. Even recently the reports on Karachi are meagre and unproductive, except on the problem of its water supply as stated above. The Government of Sind have actually stopped the publication of the ordinary Gazetteers since 1919. Only a true patriot like Seth Naomal Hotchand or a scholar like Sir Montague de P. Webb could write with some authority and vision on the past and the future of the city, as they have done. Naomal's Memoirs, introduced by Evans, is still a classic for the future historians of Karachi, as its history is still to be written.

The physical basis of the geography of Karachi and its neighbourhood has been clearly defined in Part I, side by side with its geology. It remains to be seen how the geographical control is exercised by the various factors of topography, soil, climate, plant and animal life and how ultimately man and nature have interacted in the region throughout the century of human progress. For, says Professor E. G. R. Taylor, the doyen of historical geography, "Neither the atmosphere, nor the earth's crust, nor the balance of trade, nor the growth of cities is a mere thing-in-itself. Each is part of the complex, interlocking, interacting whole, which we term man-in-his-environment. The understanding of that whole is a condition of human progress."

Again, the proper use of a region is in the production and diffusion of a culture, specially its own. A new way of life is being formed and diffused in Karachi at present and in this Part II an attempt has been made to indicate the lines on which a fresh stimulus can be given to it, so that its diffusion may take place properly in the Indus valley at first and through it in the other parts of India later on.

SECTION A:—GEOGRAPHICAL CONTROL

From the point of view of human settlement, Sind has turned out to be one of the most unstable regions in the world. Though the Indus has harboured some great prehistoric cities on its fertile banks for milleniums, witness Mohenjo Daro (2700 B.C.), and the vast and expanding delta has tempted many generations of Sindhis to establish ports at the mouths of the various branches of the river, since the days of Alexander's Patala (B.C. 325), they were, one by one, destroyed by nature with the march of time. The vagaries of the Indus, the ravages of its frequent floods, the expansion of the ever-growing deltaic region and the havoc made by blown sand in such a dry region, all have played their part in this work of destruction. The result is that Sind is a land of unstable river courses, unstable water supply, unstable population and unstable settlements. At times, a whole river system dried up, a spring disappeared, and a channel changed its course and the settlements made on them were left in decay and ruin.

1. **Birth and stability of the Settlement of Karachi.**—Except Sukkur and Kotri in the whole course of the Indus, and Karachi on the entire sea front, there are no fixed and permanent points found for human settlements in Sind. Besides hydrographical changes, there are evidences in Sind of other changes, such as tectonic, climatic, subaerial and erosional.

Such a struggle for existence has, however, made the people virile and determined to save themselves from such an annihilation. Although the delta was un-attractive and the river unstable, there were decent ports established, such as Patala, Debal, Lahri Bandar, Shah Bandar, Ghora Bari, and Keti Bandar, and the people carried on an extensive trade with the neighbouring lands of Mesopotamia, Arabia, Iran, Africa, South India and beyond. Sindhi merchants went to distant parts of the world through them by the sea routes. All of these ports had, however, to be abandoned, due to the unhampered process of silting in the harbour area and the fresh obstructions created by sand bars in front of their channels. The natives had to make constant search for a good creek region in continuation of a good river channel, small or big, and even the regions beyond the delta of the Indus were tried. For instance, after the twin ports of Lahori Bandar and Shah Bandar had come to nought

in the manner above depicted, Sonmiani at the opening of the Windar and Kharak Bandar at the mouth of the Hab were tried, but they too soon got choked with mud. Then came the turn for the mouth of the Malir and the Ghizri Bandar was established. It had the advantage of a natural communication with the Gharo Creek and through it "with the whole net work of channels intersecting the Delta of the Indus." But when this port too got silted up and the sand-bar prevented large ships from entering the harbour, the last remaining river mouth in its neighbouring viz. the Lyari, near Keamari, was sought and the birth of Karachi was heralded.

The present entrance to the harbour was at that time blocked by a bar extending from Manora to the Oyster Rocks, though the island of Manora was itself a great blessing to the harbour, but when man began to give his share in the development, the security and safety of Karachi were assured. Thus, through trial and error, the Sindhis finally succeeded in establishing the site of a port which is at once stable and promising.

2. **Physical Basis and Physiographic Divisions.**—In the Section on Physiography in Part I, all the essential physical features of the region have been shown. Planes of marine denudation have combined with the planes of subaerial denudation of the hills in the neighbourhood of Karachi to afford to the city vast open spaces flanking the two rivers, the Lyari and the Malir, for its continual growth. Some parts of the city have been actually founded in the Lyari valley and others on denuded hills and old islands which have lost their insularity partly owing to the slow rising of the land and the recession of the sea. The hills themselves are flat-topped and low, and the surrounding valleys are actually getting filled up with alluvium and blown sands. The lagoon is vast and the Chinna creek, which once harboured the entire rise of the waters of the high tide, has been partially blocked to allow only excess waters, with the result that reclamation of the sea has been carried on in this quarter with ease and rapidity, unknown in the case of other Indian ports.

Looking to the size of the City and its future planning, it is necessary to develop a kind of regionalism grounded in its physical geography as an antidote to communalism. In other words, it is necessary to divide the whole area into some physiographic subregions, according to the nature of the soil and

other physiographic characteristics found in them. Such homogeneous entities, not any haphazard administrative divisions, are likely to develop a cultural unity, which is most desirable in this capital city, as an example to other settlements in the province. Within such natural limits a kind of unification of cultures is expected.

Physiographic Sub-Regions.

Division	Extent and boundaries	Characteristics
1. Coastal Strip	The coastal area covering Mauripur, Manora, Keamari, Clifton, Ghizri, Korangi Creek, Chinna Creek.	Low lands, swampy in places and with the full control of the sea. Maritime activities of the inhabitants and defence works.
2. River Valley Sections	The lower Lyari and Malir valleys.	Good loamy soil in parts and subsoil water suitable for cultivation. Green belts likely.
3. Central Area	Closely inhabited parts of the City easily accessible and provided with amenities of life.	Intensive mingling of cultures, apart from religions, possible. Subsoil water dangerous to use. Congestion of population.
4. Hilly Region	Hills of Drigh Road, Mangho Pir, Hand's Hill and other higher parts.	Drier and warmer, but healthier areas. Suitable for colonies and hill-towns.

3. **Nature of the Harbour.**—The engineering science has enabled the builders of Karachi to improve the harbour and, supplementing the existing natural protections, have constructed the Napier Mole, the Keamari groyne, the Manora Breakwaters and lately the West Wharfs to improve the harbour works and to deepen the channel.

This has stimulated trade, both the export of raw material from the vast and fertile hinterland of the whole Indus valley and the import trade of finished products from many important parts of the world. Naturally, therefore, over 75% of the people are engaged in trade, transport and industrial pursuits.

4. **Climatic Control.**—The climate is equable due to the nearness of the sea and the gentle breeze is the greatest bless-

ing to the inhabitants for many months of the year. The latitude of Karachi gives it a sub-tropical touch, and humidity is reduced due to the neighbourhood of the Thar desert on one side and the dry Baluchistan plateau on the other. The rainfall is negligible and precarious. It only makes Karachi a suitable locality for the manufacture of salt and an excellent haven for aviation. Umbrellas are rarely found in Karachi for the same reason. Withal, Karachi has a foretaste of the Mediterranean climate, as a few showers from the western depressions in winter are usually received and storms are recorded. Grapes grow well and the pomegranate just starts ripening in summer. The neighbourhood of Karachi is barren, however, and few trees grow on the hills. The skies are generally clear, while the winds blow regularly and steadily. Dust and glare are, therefore, a regular nuisance. Skin diseases are common and the Mangho Pir hot springs are Godsend.

5. **Chances Of Water Supply.**—The greatest geographical advantage of Karachi, though it is situated very nearly on the brink of a desert, is in its sandwiched position between the river valleys of the Lyari and the Malir, both of which store regular subterranean currents of fresh water in their alluvium and have made the existence and life of the city possible for nearly a century now. The earliest water supply of Old Town was drawn from some wells in the bed of the Lyari, but as the city grew in size and population, the Malir river alluvium has been successfully tapped. Had it not been for these underground river supplies, Karachi would have shared the fate of the ancient Sindhian cities and passed into oblivion long ago. Not that the resources of the Malir have been exhausted. Its alluvium being over 50 feet deep, the evaporation of much of the underground water is prevented and the sands have allowed a continual but slow flow of water for many miles downstream. For this reason, the village of Malir is like an oasis in the Sind desert. But, as one more powerful source has been made available in the Indus river itself, though many miles away from the city, there is a chance of making the supply of water from both these sources abundant and continuous, irrespective of the unstable rainfall. The hills in the north of the city have provided excellent sites for reservoirs at the same time.

The water is charged with $CaCO_3$ and other salts in solution as well as in suspension and the Municipality has to intro-

duce an uptodate process of purification. Incidentally the stone in the kidney is likely to be a common disease among the inhabitants.

6. Buildings and Building Sites.—The levels of the greater part of the city are rather low and the building sites share the disadvantages of a locality such as this. The poorest and thickest population of Karachi, comprising the labour classes, naturally, is located in the Lyari with the congestion of business centres in Old Town near by. The well-to-do prefer the heights and distances of the few hills, while the middle classes, belonging to the various communities, have occupied the intermediate sites of the Bunder Road Extension and the Sadar Bazar. As the city area is gradually made clear of the Military Cantonment, other cultural boundaries are developed, the people preferring to live in colonies of their own. Roads are rather long, straight and wide, though some unfortunately are aligned east-west, so that the plots cannot receive the westerly breeze. The plane of subaerial denudation being uneven, frequently hollows are found in the city and they need filling in. The soil and subsoil are sufficiently deep to allow suitable foundations for buildings of any size and no solid rock is cut in many parts of the city.

Although the growth of the city is rapid and the population has increased by over 600 per cent since the 1881 census, house accommodation has not kept pace with its needs, and as the Chief Officer for the City, M. Bhojwani, has remarked "the Kutcha huts without any consideration for sanitation have a tendency to grow. The total number of buildings according to the last census is 36,045 and the number of occupied houses is 76,725. This latter figure is now estimated at one lac. The average number of persons per inhabited house vary between 3 to 6 but conditions are much worse in some quarters, where 5 to 7 people and sometimes even more crowd together in one room. There are at present 10,000 temporary huts in Lyari Quarter." This shows how congestion takes place when a city like Karachi with such vast habitable areas is allowed to grow without proper planning. (See Plate II).

7. Building Materials and Construction.—The earliest human dwellings were made of mud from the river side. Wood was naturally scarce but building stone has been found plentifully in the numerous Tertiary limestone quarries in the neighbour-

ing hills round about the city. This stone is good, durable and polishable and the structures built out of it are imposing, lasting and economical. Though a certain amount of weathering takes place also in the limestones, especially on the ground floor due to seepage, on the whole it has served its purpose well. With clay found in the same beds, cement manufacture is made possible and reinforced concrete buildings have sprung up lately. At the same time, there is the additional advantage of such concrete structures in a city lying within the earthquake zone of N. W. India.

The limestone, though soft and soluble to some extent, has been used from the very beginning as road metal. The ordinary macadam roads wore off quickly and were washed down by rain water, but now he new asphalted types of roads stand the heavy and increasing traffic well.

Sand from the Lyari river bed and this recently started cement industry have helped the manufacture of tiles, which are a speciality of Karachi. The geological structure of underground rocks helps the construction of septic tanks in parts such as Bath Island and Clifton, as the conglomerate cap overlies the soft sandstone unconformably only a few feet below.

8. **Food and Other Resources.**—Although due to the inherent barrenness of the region, there are practically no food resources within the city limits, Karachi is well supplied with cereals and cotton from the Barrage areas, and other essential requirements such as vegetables, fruits, milk, eggs, etc., from the suburbs, such as Malir and Landhi. These resources, however, have been found inadequate, again, with the growing population and a certain amount of food planning is also needed for the future. The seaboard of Karachi is an excellent breeding ground for fish, which, in an unproductive land, is another blessing. There is immense scope for improvement in the fishing industry. The typically arid climate allows some industries, while it becomes a hindrance to others.

9. **Process of Acculturation.**—Due to the unique geographical situation of the lower Indus basin with Karachi as a wide window towards the sea, there has been an influx of many peoples. Some sixteen different cultures have mingled together in this half-way house, before it is passed on to Hindustan proper. Karachi has given its valuable share in the unification of these

cultures and the formation of a special language called Sindhi and a special cult called Sufism. In spite of the province being largely Mahomedan, it is one of the most cosmopolitan cities in India, the majority of the inhabitants being home-born and even the ratio of females to males is favourable for a permanency of the settlement.

10. **Disadvantages of the Site.**—The geographical control is, therefore, more or less complete. The city is not entirely free from disadvantages, but the advantages derived from the settlement greatly outweigh the disadvantages. Though there is not much greenery round about the place and no good natural scenery due to its inherent barrenness, Karachi presents a beautiful landscape when seen from the sea under a clear sky with its low hills, its fast eroding islets and its long sea beach.

In the event of an air attack, the city has practically no exit by land other than the singular N.W.R. bridge near Malir. The low levels of the city, including some of the harbour works are in danger of being attacked by tidal waves and the old stone buildings in the city have to be protected from the rude shakings of earthquakes. Though the monsoon is generally poor on this side of our country, when it does come, the city is flooded and the drains are not properly designed or sufficient to meet such a catastrophe. With an unhampered stream of immigration of peoples by land and sea and now by air, the health and sanitation of the city are bound to be affected, although all this gives an unrestricted scope to the Municipal Corporation for new designs and new plans.

SECTION B :—TOPOGRAPHY AND HYDROGRAPHY

1. **Location.**—The location of Karachi is near the extreme south-west corner of the province of Sind, in the latitude of 24 deg. 51 mt. north and the longitude of 67 deg. 4 mt. east. It is almost in the centre of three continents, Europe, Africa and Asia, the seaboard terminus of the railways which serve Afghanistan, Baluchistan, the Punjab and Sind, the nearest port in India to Europe via the Suez Canal, being about 200 miles nearer by sea to Southampton than Bombay, and actually only 4903 miles to Croydon and 9792 miles to New York by air. It is the first Indian harbour, in which a European navy ever rode in modern times, Nearchus excluding, and the aerial gateway of the whole country today. It has been, for over one hundred years, the capital of a province, which boasts of the largest irrigation system in the whole world. (see Plate VI A.)

2. **Extent and Boundaries.**—The city, in its present extended form, occupies an area of 71.42 square miles, which includes the now gradually diminishing Military Cantonment area of 8.93 square miles. It is surrounded by the plain called the Trans-Lyari Quarter on the east and north-east, some of the Kohistan hills in the north, the Malir valley on the west and north-west and the Manora island, the Oyster Rocks and the Clifton beach in the south. The whole city limits resemble roughly a pattern 8 miles square.

3. **Relief of Land.**—The ground level gradually falls from nearly 130 feet in the north and north-east to less than 8 feet in the south-west direction, so that the whole resembles a sloping table and receives the full quota of the south-west monsoon current for about 8 miles, before it passes on to Drigh Road, which is situated a little more than 2 miles further towards the east. The high tides penetrate the southern limits of the city to the point of 6.25 feet above mean sea level. The ground contours strike more or less east and west and nearly parallel to one another throughout the entire breadth of the city. The hilly parts are mostly on the three sides of the city and the depression of what is known as Chinna Creek lies towards the south-easterly end, with the backwaters of the Lyari Lagoon forming the south-westerly one. Before the construction of the Napier Mole, which incidentally has connected the Keamari island with the mainland, the waters of the high tide

entered the Chinna Creek region and made the harbour shallow and unstable. But now the ebbing tide is "prevented from spreading and wasting its force, until it has carried the sand of the bar into deeper water and to increase the quantity of water that passes through the entrance." To the south-east of the city limit, there is another flat waste, scarcely above the high-water mark, so that there is a tremendous scope for reclamation of land in this region. The highest point within the Municipal boundaries is 223 ft. in the centre of Hand's Hill in the N.E. corner, which yet remains to be developed into a "hill-station" for Karachi.

4. **Hydrographical Features.**—The rivers within the area have been already referred to in Part I. Of these the Lyari and the Malir valleys, though dry, are very prominent features of the landscape of Karachi. (1) The Lyari is met by its tributaries, the Gujro and the Orangi, after it enters the city limits in the north and, intersecting it in its vital zone, passes beside the most thickly populated parts of Karachi. Although smaller in size than the Malir, it is a menace to the Old Town area during the brief flood season, when it is entirely in spate. The flood waters come down the barren rocks with great rapidity and intensity and communication is cut off. Its dry bed for the rest of the year makes the situation worse. Had it been a regularly flowing river at least in its deltaic area, it would have added not only to the beauty but also to the utility of the harbour. As it is, the Lyari falls into the harbour region and is another obstruction to the safety and facility of the stream due to the continuous process of silting.

A portion of the Old Lyari river actually flowed through the heart of the town some years ago. But its course has now been diverted westwards at the Dhobi Ghat, to save these parts from damage at the time of floods. The bottom of the valley is flat and sandy within the area of our study, but there are high banks on both sides, which show that it must have carried more water and more silt in the past, so that now there are chances of good gardens in these localities. In fact, there is actually a quarter of the city established here, called the Garden Quarter.

In its upper reaches, the Lyari drains nearly 27 miles of Tertiary limestone on the Mol plateau and falls from a contour

of 500 feet, so that the quantities of silt and sand carried by it during the season are comparatively great. There are no tributaries of importance except the Sham on the right and not a single town on its bank in this region. It has, throughout its course, a barren flow plain, sandy for the greater part and marshy towards the delta, which also is small and unstable due to the force of the rushing sea. The total length of the Lyari is nearly 30 miles.

(2) The Malir drains the Mol plateau but with the aid of two powerful streams, the Mol (nearly 50 miles long) with a few tributaries and the Khadeji (nearly 30 miles long) with several tributaries. The former has a somewhat narrow catchment area and falls from higher levels, about 2,000 feet, and supports some villages called Pitok, Shange, Shahbeg, Mahund and Buram, while the latter leaves the 1,000 feet contour and has a wider catchment area but has only two small settlements, Sari and Khamis Gadra. It has, however, the merit of a perennial spring with a surface flow for nearly 5 miles and a waterfall about 12 feet high near the Khadeji gorge, some 29 miles from Karachi on the Sehvan Road. The divide between the Khadeji and the Mol is about 1,400 feet high.

After the confluence of both these streams, the river with a level of some 300 feet assumes a single name, the Malir, and again passes through what is called the Dumlotte gorge, which is very poor compared to the Khadeji gorge. In the case of the latter gorge the side-hills of sandstones and limestones rise to a height of over 200 feet and the water-shed on the upstream side covers some 200 square miles, so that, if a dam could be constructed in this locality, it would impound over 5,000 million gallons of water. Below the confluence, the Malir meets some minor streams e.g. the Jarando, the Bazar and the Thaddo on the right and the Sukkan river on the left, which are good tributaries during the flood season. Here the ground level is reduced to about 175 feet. Below the confluence, the Malir itself is about 20 miles in length. Throughout its course the river bed is flat and strewn over with sand and gravel, which is over 60 feet below the surface in some places. There is the presence of mica in them, which combined with the facts that there are a few terraces and river cliffs especially in the Khadeji valley, indicates that there was some greater activity of the river under a more favourable climate in the past geological periods. The

width of the alluvium increases from a few hundred feet near the confluence to a few miles near the delta.

The Malir, being an important river from the point of view of Karachi water supply, some important observations have been made by the Government engineers on the surface run-off. Mr. D. A. Howell writes in one of his reports: "The measured run-offs of the Khadeji and Mol were taken systematically at points some little distance above the confluence. The run-off of the Khadeji against a total rainfall of 7.53 inches amounted to 28.2 per cent. and that of the Mol, against a rainfall of 5.71 inches, amounted to 41.18 per cent.

"If observations had been taken downstream on the Malir, say at the Dumlotte Gorge or at Wells Nos. 1 and 2, they would have indicated that the run-off at these points was much less than the figures given above, due to percolation into the alluvium in between. At the same time, all the run-off, even from rainfall, occurring after periods of drought, is not absorbed by the alluvium unstream of say, Wells Nos. 1 and 2 or even upstream of the N. W. Railway Bridge."

These observations were taken during the year 1932. Mr. Howell refers to this subject again in connection with the season of 1937: "The alluvial deposits, however, are replenished not only by direct flow of the rivers during or following falls of rain, but also by the dry weather flow, which in the case of the Khadeji was observed to be 600,000 gallons per diem in June 1937. This is derived from part of the rainfall on the catchments, which percolated into the ground and, after wending its course along planes of joints, faults, fissures and hollow places, is discharged gradually in the form of springs." All these observations are important from the point of view of the city's water supply from this valuable source.

Indeed, this dry, sandy-gravelly bed of the Malir has been a blessing to Karachi from the point of view of its water supply, as in the words of Mr. Bhide, the present Special Water Works Engineer, "the supply is partly derived by gravity in some months and by medium pumping in most of the months, from a sandy substrata—in a perfectly pure condition, sparkling and transparent,—a condition that would be absent in the raw water to be derived from the Indus." Not only this, but the drift soil derived from the native rocks also supplies some

vegetation and there is a number of agricultural wells sunk on both the banks in this part of the valley.

Near Drigh Road, the Safuran Nala meets the Malir. As we approach the lower reaches and the deltaic area of the river near Ghizri, the sands predominate and support no vegetation, which is unfortunate for the city, as it cannot profitably expand on this side and utilise it as a green belt. Towards the delta and below Drigh Road the expanse of the river bed is big, so that there is not a single road or bridge crossing the Malir, except the N.W.R. bridge near the Malir R. S. Remarkably again, the mouths of both the rivers widen out, instead of coming closer near the City parts.

(3) The Hab, the only perennial river in the neighbourhood of Karachi, has not been profitably tapped for its water supply. It drains some 220 miles of hard Tertiary rocks in Baluchistan and Las Bela state, with the last 70 miles forming a natural boundary between Sind and the State and falls through a height of 6,000 ft. in the Kirthar mountains. It is never without pools of water in the lower valley, which can be easily forded. It has, however, no good sandy pockets as in the case of the Malir or the Lyari for any scheme of water supply, and except perhaps near Hinidan, no good site for a dam though it is very doubtful. Some 75 years ago, a Bund was actually constructed at the spot, where the road crosses into Las Bela territory, by Murad Khan, who was granted a land by the British Government, but owing to the absence of a good gorge, this embankment was broken through by a heavy flood and portions of it were swept away. Had it been successful, it would have supplied water for irrigating over 33,000 acres of fields and sufficient drinking water to Karachi, lying only about 25 miles to the east.

5. **Subsoil Water Table.**—The level of subsoil water throughout the city limits varies from some 20 feet in the higher areas to within 2 feet in the lowest parts of the City. This water-table rises again as we approach the banks of the rivers on both sides. The depth of wells in Sadar Bazar is hardly 6 feet, but the water is mostly salty, being derived from Kalar soil and subsoil charged with $CaCO_3$, except where there are some fresh water springs in the alluvium alongside the various Nullas made for surface run-off in the city during the rainy season. Wells dug in the neighbourhood of these channels

provide tolerably potable water, if it is not infected by any sub-soil drainage. This was observed when some A.R.P. wells were sunk in the City during the period of the World War II. (See Plate III).

6. **Cultural Boundaries.**—The soils, wherever derived from the underlying limestone in the higher levels of the city, are calcareous and heavy. They are suitable for cultivation, the calcium-magnesium ratio being tolerable. But where the ground is charged with Kalar and where there is even '5% of soluble salts, the soil does not readily support vegetation, unless these salts are washed down by leaching them into deeper layers. Again, where the soil is sandy, along the banks of the rivers in certain other parts, there is no cultivation possible, and no growth of natural vegetation, except coarse grass and cactus plants (Ref. Part I Section F.)

The coastal area is either swampy or sand-ridden and, therefore, there are no chances of the growth even of palm trees.

The cultural boundaries made by the people follow its topography to a great extent, the well-to-do have occupied the heights wherever they are, the middle-class colonies have taken advantage of the available slopes and midlands, while the poor labourers and others have to be content with the depressions, especially the Lyari Valley area where there are the Dhobi Ghat, the Khumbarwara, the Chakiwara and the Machhi Bazar. Though the Ghizri hill is yet unoccupied by any colony, a number of bungalows have been built at Clifton, Bath Island, Honeymoon Hill, and other hilly areas in the north of the city around the Cantonment. On the whole, there is a tendency in Karachi to start colonies on communal lines and on the high ground of the Bunder Road Extension. One sharp cultural boundary has also developed in the Commissioner's Maidan after the reoccupation of the land from the Military. The main arterial roads constructed by the Municipal Corporation are the singular Bunder Road—Extension and the Garden Road—Victoria—Clifton Road, cutting right across the city and stimulating a certain type of cultural alignment.

SECTION C :—CLIMATE

1. **General Sind Conditions.**—In the matter of climate, Sind plays a unique part in the cycle of the general climatic conditions prevailing in India. Sind is at once the driest and hottest of all the regions, aridity being its common feature. Actually the thermal equator passes through the lower Indus basin. These conditions are accentuated by its orography, the nearness of the Thar desert in the east, the Kirthar mountains with their peculiar re-entrant angle in the west and north-west and the Arabian Sea in the south. Thus the temperatures are exceptionally high in summer and rather low in winter.

Over Sind, in the summer months there is a persistent depression with an oval isobar of only 29 inches round about Jacobabad and an isotherm of about 100 deg. F. co-terminous with it. There is, therefore, a difference of nearly an inch of barometeric pressure between South India and Sind, which at once becomes a theatre of great atmospheric depressions, breeding thunderstorms and air disturbances. Thus our region of Sind acts as a powerful stimulant to the S. W. monsoon and contributes to the rainfall of the whole country, while it itself suffers both from high temperatures and scanty precipitation.

By the end of September, when the meterological conditions in India are reversed and a high-pressure system hangs over the greater part of central Asia, the monsoon current cannot enter this region but retreats and goes round the area of low pressure created in South India. This is called the retreating or N. E. Monsoon. This current also does not affect Sind, as it gets gradually exhausted in its passage westwards. Thus, Sind is said to be "lying between the two monsoons" and does not get the benefit of either. What little rainfall it gets is often due to cyclonic storms, caused by the eastern and the western depressions, particularly the former. During winter, the western depressions, generated as far as the Atlantic Ocean and the Mediterranean Sea, pass through the region of high pressure or the anti-cyclonic belt and moving north-eastwards along a big front, generally cover the Indus valley. Though these western depressions occur several times during a winter month, only a fringe of them affects Sind and we get a few inches of rain sometimes. Thus the average rainfall in Lower Sind is hardly 7 inches. It is not only so scanty but also extremely variable and unreliable.

The diurnal and monthly ranges of temperatures are great, though near the sea coast it is less and the climate of Karachi becomes equable throughout the year. Humidity also varies from month to month and season to season. The weather is generally drier and cooler in winter and wetter and hotter in summer. The skies are frequently clear and frost is not uncommon. While it is usually calm for nearly half the year in upper Sind, nearer the coast the wind velocity increases from 15 to 20 miles or more per hour in the monsoon season. Dust storms and squally weather are common in the beginning of both the summer and the winter seasons. The predominent wind direction is westerly and south-westerly except in winter, when it is changed to north and north-west.

But the greatest peculiarity of the climate of Sind in general is that after gaps of about six years of scarcity of rainfall, there are peaks of good and at times heavy rainfall, as heavy as 30 inches, and that too received only in a few days or a few hours in the year.

2. **Local Differences In Climate.**—There are, besides, in Sind local afternoon disturbances due to convectional currents and contrasts of weather conditions, such as high temperatures, diurnal ranges and differences in humidity, which cause thunderstorms, dust-storms and squally weather during the transition stage between the two seasons, viz. March to May and September to November.

In addition to these there are local land and sea breezes near the coast. In the words of Dr. Ramdas "The sea breeze first sets in at Manora, then moves towards Drigh Road through the Karachi City. The time taken by the sea breeze to reach the Airship Base varies from one to three hours. Before the arrival of the breeze at the Airship Base, the previous land-breeze, if any, drops to calm and the setting in of sea-breeze is accompanied by a fall of temperature (from about 5 deg. F to 3.5 deg. F), rise of humidity (from 5% to 30% and above), shift of wind direction to west, south or south-west and an increase of wind velocity. The transition from land breeze to ea breeze is more marked, as the latter proceeds inland. The sea-breeze front appears to be somewhat diffuse near the coast but by the time it reaches the Airship Base, it becomes quite sharp owing to increased contrast with the land breeze."

(1) **Temperature.**—The accompanying tables (Nos. I & II) show that there are some marked differences in the two places, Manora and Drigh Road, though they are not far apart.

TABLE I

Max. and Min. Temperatures at Manora.

Year	January		February		March		April		May		June		July		August		Sept.		October		Nov.		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1933	74.0	56.8	73.9	62.0	82.1	67.5	85.9	74.7	88.7	79.5	90.3	83.0	88.2	80.3	84.9	77.2	87.2	77.4	87.7	73.9	85.6	69.0	79.7	62.7
1934	72.0	52.2	77.0	61.6	80 9	67.0	86.8	74.9	89.1	79.6	89.9	81.4	89.0	81.7	87.6	80.6	85.9	77.8	86.5	73.5	84.9	68.8	79.8	63.0
1935	71.5	54.6	76.1	62.2	82.5	68.6	84.0	73.3	87.5	77.6	88.9	80.5	88.0	80.2	84.3	77.3	84.2	75.9	87.6	73.0	84.8	70.0	79.2	62.0
1936	75.2	56.5	77.9	61.1	80.5	66.0	84.8	74.2	88.4	80.2	90.8	82.9	87.7	80.3	85.6	78.5	85.2	76.7	86.1	74.5	84.9	67.4	79.0	62.3
1937	77.0	57.4	79.2	63.2	81.9	67.2	85.3	73.3	87.7	79.0	90.2	82.0	89.1	80.6	86.2	78.9	86.0	77.0	87.9	73.9	86.1	68.1	76.6	57.8
1938	73.3	56.6	76.7	59.4	80.9	69.4	84.0	74.0	88.6	80.1	91.0	83.8	87.1	80.4	84.2	77.5	84.1	76.4	85.1	72.6	84.1	64.4	79.2	58.6
1939	77.5	58.0	75.4	62.1	79.6	66.0	83.8	71.8	85.1	77.0	89.4	82.2	85.7	78.8	84.3	76.8	84.4	76.3	85.5	73.0	87.8	68.3	82.6	62.9
1940	77.9	60.5	77.0	62.3	79.4	67.9	84.2	73.0	89.4	79.7	90.1	82.7	89.0	81.9	85.2	78.0	83.8	75.2	87.3	75.4	87.9	69.9	80.6	61.5
1941	77.0	58.1	80.0	64.7	82.6	72.2	85.6	76.4	88.5	81.0	90.1	83.5	86.6	80.5	86.2	80.0	85.4	77.2	88.1	77.4	86.9	68.9	80.3	61.1
1942	75.4	58.0	78.1	62.0	83.4	69.6	85.4	76.3	88.2	80.4	89.2	82.0	88.4	81.3	84.2	77.5	85.0	76.8	86.2	74.4	84.9	70.9	78.4	59.1
Mean	75.1	56.9	77.21	62.4	81.4	67.1	85.0	74.2	88.1	79.4	89.9	82.4	81.6	80.6	85.3	78.18	85.1	76.7	86.8	74.2	85.8	66.7	79.3	61.1

(Data supplied by Director, Regional Meteorological Centre, Karachi.)

TABLE II

Max. and Min. Temperatures at Drigh Road.

Year	January		February		March		April		May		June		July		August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min.	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max.	Min	Max	Min
1933	77.0	49.7	81.1	56.3	88.2	61.5	94.5	71.6	87.1	77.5	92.8	82.4	90.7	80.5	87.6	77.8	90.2	76.3	93.5	67.5	90.0	60.3	82.6	54.1
1934	73.5	44.0	84.3	54.7	87.4	60.6	97.8	69.5	95.7	77.2	94.4	81.2	90.4	80.8	89.9	80.4	89.8	77.0	94.3	66.0	90.5	60.7	82.3	56.7
1935	73.6	49.1	80.1	56.8	88.2	62.6	90.5	70.2	96.4	76.7	96.2	81.2	91.0	80.9	87.1	77.1	89.3	76.4	93.5	67.0	90.0	62.5	81.6	55.3
1936	76.5	50.2	80.6	57.5	85.9	62.3	93.3	71.2	95.0	78.4	94.4	82.3	89.1	80.1	87.7	78.5	90.3	76.5	91.4	70.4	88.1	61.3	80.3	56.7
1937	78.5	50.8	81.3	57.3	86.3	61.8	94.3	67.8	94.5	78.1	94.3	81.9	91.4	80.9	87.3	79.2	89.3	77.0	93.4	67.6	89.9	60.8	77.5	50.9
1938	74.5	50.8	79.6	53.3	89.1	64.4	96.2	69.8	95.7	79.5	95.3	83.4	90.0	80.5	87.9	78.2	88.6	76.5	95.1	69.3	87.6	56.6	80.8	51.1
1939	79.1	51.4	77.3	56.9	83.2	61.5	91.7	67.1	94.1	76.7	92.0	81.7	89.3	79.5	88.0	77.8	88.6	77.0	92.9	70.1	92.6	61.8	84.1	55.4
1940	78.7	54.6	80.6	57.0	82.9	63.2	92.7	67.9	96.5	78.7	93.4	81.7	91.9	81.5	88.5	78.9	89.1	75.7	95.8	70.7	92.6	63.1	81.0	54.0
1941	77.5	51.3	85.3	57.6	90.1	66.6	94.8	73.6	93.7	79.4	94.0	83.1	89.5	80.5	89.5	80.2	89.7	76.6	95.9	74.1	92.2	60.5	83.2	53.2
1942	76.5	52.7	80.5	56.7	92.0	64.1	94.0	74.2	93.1	79.5	95.8	81.7	90.8	81.0	88.0	78.1	89.3	76.8	94.2	71.7	90.3	63.2	79.6	51.2
Mean	76.3	50.5	81.1	56.4	87.3	62.8	94.0	70.3	94.1	78.2	94.4	82.1	90.4	81.6	88.2	78.5	89.4	76.8	94.0	69.4	90.4	61.1	81.3	53.9

(Data supplied by Director, Regional Meteorological Centre, Karachi).

The range of temperature is also different, as can be seen from the following table:

TABLE III

Monthly Range of Temperature at Manora and Drigh Road:

Month	Manora	Drigh Road
January	18.2	15.8
February	14.8	24.8
March	14.3	14.5
April	10.8	23.7
May	8.7	15.9
June	7.5	12.3
July	1.0	8.8
August	6.2	9.7
September	8.4	12.6
October	12.6	24.6
November	19.1	29.3
December	18.2	27.4

("India Weather Reviews")

At both the stations, the range widens during winter, considerably more at Drigh Road than at Manora, but narrows down during the summer months, decidedly more so at Manora than at Drigh Road. It is a steady rise and fall at Manora due to the moderating influence of the sea, but it is quite erratic at Drigh Road. The maximum range is in November, while the minimum in July at both the Stations.

A study of the thermograph at Karachi also shows the daily range to be the smallest in July-August and the greatest in November. The day's temperature is the highest in the afternoon at about 2 p.m. and the lowest in the early morning at about 5 a.m.

(2) **Barometric Pressure and Relative Humidity.**—The barometric pressure as well as the humidity is higher at Karachi than at places inland.

Humidity also varies from month to month during the year.

TABLE IV

Barometric Pressure and Relative Humidity at Karachi (Manora)

Month	Barometric Pressure	Humidity	Remarks
	Inches	%	
January	30.090	61	
February	30.062	67	
March	29.938	71	
April	29.831	76	
May	29.723	78	
June	29.560	79	
July	29.522	82	
August	29.599	84	Moistest month
September	29.747	82	
October	29.902	74	
November	30.024	62	
December	30.090	58	Driest month
Annual	29.839		

("India Weather Reviews"—averages of 30 years, 1901 to 1930)

The winter months are drier than the summer and monsoon months. The humidity in the inland parts is decidedly less than at Manora. Thus the air round about Drigh Road and Mangho Pir is drier, though hotter, in summer and, therefore, not so oppressive as in the city of Karachi.

(3) **Wind System.**—The following table indicates the wind system throughout the year:

TABLE V

Wind System at Karachi.

	Season	Wind direction	Number of days during the year.	Wind velocity m.p.h.	Remarks
(a)	Cold season	N.W.	35	6.5	N.W. wind very
		Calm	25		few days of
		N	33		calm
(b)	Dry hot	N. E.	69		
	Season	E	16	12.0	N. E. Wind
		S. E.	4		predominent
(c)	Monsoon	S	3		
		S. W.	50	11.7	Westerly wind
		W	130		predominent.

("India Weather Reviews"—average of 20 years, 1901 to 1920)

The winds in Karachi blow practically from all directions during the year but the westerly wind predominates and maintains the temperature to about 70 deg. F on the whole. The velocity of the wind during the hot and monsoon seasons is good but it reduces as it progresses inland and as the winter season approaches. Both the monsoon winds and the sea breeze keep Karachi cool for the most part of summer.

(4) **Cold and Heat Waves.**—As the disturbances from far-off regions approach Karachi and its neighbourhood, the weather becomes invariably abnormal i.e. abnormally hot at one time and abnormally cool at another time. Such weather spells are rather frequent during winter, when the western depressions cross the Indus valley e.g. about half a dozen in the month of January and some more in February when rain is expected. They have a mass of warm air in their southern and eastern quadrants and cool air in the northern and western quadrants. Whenever these western depressions cross a mountain like the Kirthar Range, the storms develop "secondary depressions" which cause disturbed weather in Sind. As soon as they approach a station there is a rise of temperature, which then drops to several degrees below normal, at times as many as 10 deg. F, and there is snowfall on mountain tops or rainfall on lower levels. Similarly eastern disturbances take place in the hot wet season.

Between the two stations of Manora and Drigh Road, hardly 10 miles distant from each other, there is a difference of as many as 12 deg. F as a drop in temperature in winter or a similar rise in summer, at the time of such a disturbance.

(5) **Rainfall.**—Although the rainfall in Sind and Karachi is meagre, as stated before, it is a very useful supplement to our underground water supply.

TABLE VI

Annual Rainfall at Karachi and Neighbouring Places.

Year	Manora	Karachi	Drigh Road	Malir Bungalow	Dumlotte	Khadeji R.G. No. 2
1930	16.07	10.17	13.52	9.36	7.95	8.25
1931	0.73	0.98	0.69	0.61	0.84	1.24
1932	12.78	9.76	9.41	9.54	8.49	10.86
1933	20.11	19.56	20.82	18.67	9.91	15.70
1934	8.44	7.11	6.97	5.02	6.60	7.05
1935	3.45	4.01	5.68	4.87	3.93	2.40
1936	4.21	3.47	5.39	4.19	3.59	4.38
1937	11.73	10.03	11.39	13.00	7.91	6.04
1938	4.73	4.20	7.54	6.92	6.18	9.12
1939	4.54	3.45	3.31	3.83	3.39	2.45
1940	10.84	8.63	9.90	9.78	7.88	11.66
1941	1.91	2.29	1.93	2.57	3.10	1.58
1942	13.11	8.67	9.96	6.80	6.49	5.17
1943	2.93	2.71	——	2.65	1.85	1.04
1944	26.63	28.50	——	20.85	25.17	25.22
Average	9.48	8.22	8.19	7.91	6.87	7.48

The above table reveals the following facts:—

(a) The rainfall decreases as we go inland, although distances are not great.

(b) It is very meagre and very variable at all the stations.

(c) There are several years of great scarcity of rainfall to balance some years of abnormal rainfall and floods, although a cyclical period cannot be fixed.

(d) At times a whole season's rainfall is received in 2 or 3 days.

(e) The actual monsoon period is from 9th July (commencement) to 23rd July (withdrawal). (See Plate VI).

TABLE VII

Monthly Rainfall at Manora.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total for the year
1930	0.44	0	0	0.11	0	2.09	13.37	0.05	0.01	0	0	0	16.07
1931	0.06	0.22	0.21	0	0	0	0.19	0.05	0	0	0	0	0.73
1932	0.21	0	0	0	0	0	11.44	1.13	0	0	0	0	12.78
1933	0.05	0.05	0	0.05	0.22	0	15.44	3.03	1.27	0	0	0	20.11
1934	0	0	0.08	0	0	1.28	6.49	2.03	0	0	0	0	8.44
1935	0.64	1.16	0	1.20	0	0	0.31	0.19	0.01	0.03	0	0	3.45
1936	0.05	0.57	0.07	0	0	0.72	2.64	0.01	0.03	0	0.01	0.01	4.21
1937	0	0.96	0	0.01	0	0	8.14	0.03	0	0	0	0	11.73
1938	0.01	0	0	0.04	0.12	0.06	1.66	2.61	0.01	0	0	0	4.73
1939	0.01	2.01	2.21	0.08	0	0.02	0.02	0.02	0.01	0	0.16	0.16	4.54
1940	2.70	1.27	1.83	0	0	0.40	2.09	2.15	0	0	0.03	0.03	10.84
1941	0.10	0	0	0	0	0	1.77	0.01	0	0	0	0	1.91
1942	0.61	1.09	0.18	0	0	0	10.11	0.71	0	0	0	0	13.11
1943	0.71	0	0	0	0	0.13	1.99	0.09	0.01	0	0	0	2.93
1944	0.23	1.87	0	0	0	0	11.28	13.19	0	0	0	0	26.63
Average	0.39	0.61	0.30	0.50	0.02	0.31	5.78	1.57	0.10	.001	.011	.011	9.48

(Data supplied by Director, Regional Meteorological Centre, Karachi.)

TABLE VIII

Monthly Rainfall at Drigh Road.

Year	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Toal for the year
1930	0.27	0	0	0	0	1.28	11.79	0.14	0.04	0	0	0	13.52
1931	0.05	0.14	0.17	0	0	0.05	0.22	0.06	0	0	0	0	0.69
1932	0.06	0	0	0	0	0	7.99	1.29	0.07	0	0	0	9.41
1933	0.04	0.03	0	0.09	1.31	0	13.99	2.98	2.38	0	0	0	20.82
1934	0	0	0.02	0	0	2.10	4.58	0.28	0.01	0	0	0.18	6.97
1935	1.03	1.06	0	2.08	0	0	1.04	0.30	0.15	0.02	0	0	5.68
1936	0.07	0.65	0.05	0	0	2.32	2.20	0	0.10	0	0	0	5.39
1937	0	1.42	0	0	0	0	8.65	0	0.15	0	0	1.17	11.30
1938	0	0	0	0	0.13	0.34	3.78	2.75	0	0	0	0.54	7.54
1939	0	1.99	1.26	0.02	0	0.03	0	0.01	0	0	0	0	3.31
1940	2.1	1.18	0.96	0	0	0.81	2.26	2.29	0	0	0.04	0.30	9.90
1941	0	0	0.04	0.02	0	0	1.85	0	0	0	0	0.02	1.93
1942	1.01	1.17	0.26	0	0	0	6.65	0.83	0	0	0	0.04	9.96
1943 1944	Figures are not available												
Average	0.34	0.58	0.21	0.17	0.11	0.53	5.00	0.84	0.22	.001	.003	.17	8.19

(Data supplied by Director, Regional Meteorological Centre, Karachi.)

Thus, though the rainfall is meagre, there are two distinct rainy seasons (1) the S.W. Monsoon period and (2) the period of western depressions in winter. There is, however, decidedly more rain in the former season than in the latter.

TABLE IX

Rainfall at Karachi (Pre-Barrage period).

Year	Rainfall
1901	1.37
1902	18.23
1903	4.58
1904	4.62
1905	3.64
1906	6.47
1907	7.75
1908	6.45
1909	7.09
1910	12.63
1911	4.84
1912	3.17
1913	13.45
1914	9.34
1915	2.26
1916	21.87
1917	5.63
1918	2.04
1919	3.39
1920	1.97
1921	16.90
1922	1.99
1923	5.57
1924	3.69
1925	4.38
1926	20.04
1927	8.90
1928	2.39
1929	4.13
1930	16.70
	Average 7.51

(Data from "India Weather Reviews")

It can be seen that the average rainfall during the pre-Barrage period was a little less than that at present viz. 9.48 inches at Manora, 8.33 inches at Karachi and 8.19 inches at Drigh Road. When the Barrage was opened in 1932, it was a common belief that the rainfall would increase due to extended irrigation and more evaporation and vegetation. But the period of a dozen years is not enough to come to any definite conclusion. Such climatic changes, again, are not dependent on local circumstances but on world-wide atmospheric conditions. However, there is plenty of evidence of a higher rainfall in Sind during the period of the Indus valley (Mohenjo Daro) culture, due to the deflection of the Monsoon current. (For further discussion on the subject vide—"Climate conditions in Sind" Karachi, 1937). Also, (See Plate IV B).

TABLE X

Comparison of Rainfall at the Chief Sea Ports of India.

	Directions of Monsoon	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1. Karachi (Manora)	S.W.W.	0.3	0.6	0.3	0.5	0.02	0.3	5.7	1.5	0.09	0.0	0.01	0.2	9.5
2. Bombay	W.S.W.	0.1	0.0	0.0	0.1	0.5	21.1	25.0	15.0	11.0	2.0	0.5	0.1	75.2
3. Colombo	S.W.	3.5	1.9	4.5	7.8	13.0	7.7	6.5	3.0	5.9	13.0	11.0	5.0	82.8
4. Madras	S.W.—N.E.	1.1	0.3	0.3	0.6	1.8	2.0	3.8	4.5	4.9	11.2	13.6	5.4	49.5
5. Calcutta	S.E.—N.E.	0.4	1.0	1.4	2.0	5.0	11.0	12.0	11.5	9.0	4.3	0.5	0.2	58.3
6. Chittagong	S.E.—N.E.	0.4	1.0	2.4	4.7	9.8	21.9	24.6	20.9	13.5	7.1	1.7	0.7	108.7

The rainfall decreases as we go higher from Colombo to Karachi on the west coast and also to Calcutta on the east coast, but to a lesser extent on the latter side. There are more rainy months on the east coast than the west coast, due also to the effects of the retreating monsoon during the winter months. Karachi is decidedly the driest of all the Indian seaports. (See Plate IV A).

The climographs of Karachi and Madras give, again, an interesting comparison. (See Plate VII A). They show how the rainfall spreads over the whole year in Madras, while it is restricted to a few months or days in Karachi, and at the same time the thermometer rises to almost the same height at both the places in summer.

Conclusion.—Although, owing to the nearness of the sea, the climate of Karachi is generally mild and healthy, it becomes oppressive at times. In winter the cold is not quite dry and steady as it is in Upper Sind and the Punjab but damp and breezy and therefore piercing, while the heat of summer is unbearable whenever the Monsoon current is reduced in strength and there is a break in it, with no sea breeze practically.

But, on the whole, the climate is tolerable all throughout the year although it is peculiar, and bracing although without sufficient rainfall. Indeed, there are few cities in India which can boast of such a climate, approaching the ideal in some months, as at Karachi, viz. 70 deg. F temperature and 80% humidity. Scarcity of rainfall is compensated for in cloudless skies and plenty of sunshine, which in their turn offer ultra-violet rays for life to grow and the people to enjoy. The hottest days become tolerably pleasant on account of the continuous sea breeze, which is received in some houses through the peculiar wind-sails for which Sind is so well-known.

But the special merit of Karachi's climate is in the potency of the 'small storms' particularly the western depressions, which visit the Indus valley, being on the fringe of the Atlantic storm-belt during the winter months. Peaks of heavy floods alternating with a number of rather rainless seasons cause a variable climate, in which eastern cyclonic storms also play their part in summer. Karachi and Sind differ from other parts of India in this respect. All the stimulant to energy arises from these disturbances. There is practically not one climate, then, in Sind, but so many 'micro-climates', as they are called, in the different parts of Sind, and in different localities within a particular area. Herein lies the secret of its culture and also its future. No wonder the civilisation of Mohenjo Daro itself was generated within this zone.

SECTION D.—PLANT AND ANIMAL LIFE.

1. **General Characteristics.**—The vegetation regions and subregions of the lower Indus basin, of which our area forms part, correspond more or less with the climatic ones. They are delimited in terms of the precipitation and temperature values. Thus semi-arid and arid types are predominent, the latter type being more widely scattered. But some parts of Sind, having fallen within the command of the Lloyd (Sukkur) Barrage and other inundation canals, are easily subjected to reclamation by irrigation.

Due to the irregularity of the rainfall curve, there is also a frequent range from the arid to the semi-arid and from the semi-arid to the subhumid type, and vice versa. There is therefore a great climatic risk to agriculture in our region, unless more and more canals are cut and distributaries properly administered.

Both the geographical situation and the climatic conditions prevailing in the region have given a peculiar turn to the organic life. Its affinity is more with the extra-tropical lands in its neighbourhood than the main country of India. Nearly one third of the plants belong to the types actually found in Afghanistan, Iran, Arabia and Egypt. This is possible, because both the soil and the climate are common to them. Thus the plants, which grow well in these foreign countries, can also be grown in Sind with success, because of the excessive summer heat, severe cold in winter and dry and salty soil. Here in our province, the date tree ripens first from the equator northwards and brings its fruit to perfection. The apple produces an eatable fruit and the pomegranate just starts blossoming for the first time. Dye plants, gums, resins, and other drug-yielding and xerophytic grow well. It is a stage of organic life intermediate between tropical India and temperate Iran. In fact, the physiognomy of African plants is found stamped on the flora of Sind, which would otherwise resemble those of India.

Similarly the animals, typical of both the subtropical and the tropical desert, are natives of Sind. The ox, the ass, the camel, the jackal and other kinds are well-known. Even the birds resemble those well-known in Iran, Arabia and North Africa. Only a few mammals live here, because of the same

reason, viz. scanty vegetation. Marine fish, identical to those living on the Malabar Coast, are well known, while locusts find their breeding places in the neighbouring sand hills.

Karachi and its neighbourhood share this organic life to some extent, although the nearness of the sea and the drift soil and sand affect it.

2. **Plant Life.**—The plants, found within the area of the present study can be arranged into three groups (1) those thriving in the coastal subsection, (2) those living along the banks of the two rivers and (3) those found on the interior hilly parts.

(1) **The Coastal Type.**—Various kinds of algoe, sea weeds and rose-tangles are found on the Manora island and on the littoral grounds. All along the coast, mangroves grow plentifully e.g. **sonneratia, cerops, rhizophoraceae.** Convalvulaceae or the sand-binder also lives amidst scrubs and coarse grass in the sands along the sea coast.

(2). **Fresh Water Vegetation.**—In the valley of the Lyari and to a certain extent in that of the Malir, some typical fresh-water vegetation lives. Fresh algaes are represented by **Oscillaria,** date palms by **phoenix, dactylifera, cocos mucifera** (Cocoa-nuts), pines by **conifers** and **casuarina** trees by **casuarina equisetifolia.** (Beef-woods).

A large number of garden trees, plants and fruit trees can also grow e.g. Castor plant, water lily, crow foot, pipal, nim, bannana, banyan, papaya, mango, pomegranate, tamarind, babul, **(acacia arabica)** and other Mimosa varieties.

Among the grasses found there are **Andropogon aunulatus** and **Dactylotenium aegypticaum.** In the Hab valley, certain varieties of **Gymnospermons ephedra** are discovered. Palm fossils are among those found in the lignite deposits of Landhi.

(3). **Dry Hill Vegetation.**—There is practically no good vegetation on the hills; but, if any is found, it is on the slopes or in the valleys below. Algaes, e.g. **Oscillaria** and **Spirogyra,** grow at Mangho Pir. **Salvadora indico** (a sort of camel fodder) grows wildly and among other plants there are the Dhatura, cactuses, castor plants, etc.

Medicinal Plants.—In the dry hills of Sind Kohistan especially, e.g. Drigh Road, a large number of perennial herbs;

medicinal properties, grow. Arid climate and shallow soil suit these plants, because of their dry and hot They do not allow plants belonging to other species in their neighbourhood. Some of them are goat-foot Babul (**Acacia**), thorn apple (**Dhatura Alba**), Kirbet dina **bonduc**), **aristolochia**, etc. Various organs of plants are determined to have medicinal properties and by Vaids and Hakims locally.

Animal Life.—The animal life, being mobile, although lled by the region, cannot be definitely assigned to any localities. Jackals, hyenas, hedgehogs, dogs, donkeys are common. In the coastal area, poisonous snakes, poisonous than those found inland, seek shelter. Crocolived long in the fresh-water pools of Mangho Pir. met with in caves near Clifton, while common house as rock lizards, scorpions, snakes, rats, earthworms, and wild cats roam all over the area.

life is also typical. Among them can be seen the catcher, the sand-piper, the common crane, the brown the hawk, the kite, the owl, the bee eater, the Sind d-pecker, the crested bulbul, the black robin, the comia, the dove etc. Migratory birds are not absent.

life consists of a vast number of creatures, such as moths, butterflies, mosquitos, spiders, ants, cockroThe termites or white ants thrive well in Karachi a menace to book lovers and librarians.

Types of Animals (a). Fish and Fishing Ground.— a good variety of marine fish found in the coastal ularly star-fish, jelly fish, sea anemone, blue-, shark, saw-fish, sea-urchin, crab, lobster, prawn, mallet (Boi), Bombay duck, pomfret, sheer, s) and Surmai. Prawn fish is a speciality of the arket and is exported to other parts of India e.g. d Colombo. It prefers warm water and is therefore found during summer on the Makran coast. coast, on the whole, is congenial to the life and le fish owing to the following reasons:

ere are comparatively shallow waters on the sub- which is hardly five fathoms deep and is broader

than even the Bombay or Madras Coast, as it forms part of the continental shelf after the submergence of the Indus Delta.

(ii). The delta of the Indus is a growning one, which makes the coast very shallow and at high tide it is largely submerged, so that the sea water rushes several miles inland. Thus the many outlets of the river channels become the inlets of the sea, producing a regular alteration of fresh and salt waters.

(iii). The Karachi and other adjoining lagoons and mangrove swamps, formed against the numerous sand-bars, are also suitable breeding ground for fish.

(iv). The silt dropped by the rivers, the Hab, the Lyari the Malir and even the Indus, is considerable. This makes the waters near the sea coast muddy and rich in minerals during the season and helps the growth of sea weeds, which supply food and shelter to the fish living in them.

(v). The cold season particularly in these latitudes helps to keep the water, which remains warm in summer, rather cool for at least four months of the year. This combination of hot and cold currents, near the sea particularly, influence fish life.

On the whole, the coast presents a good breeding and gathering ground for fish and Karachi would make an excellent fish research station on this side of India.

An extraordinary thing has happened to the fishery trade in recent years. Herrings have become very rare and with them other big fish have also been affected. Herrings and prawns, for instance, generally go together and it is feared that the lucrative prawn trade in Karachi will suffer, if steps are not taken in time.

Thus, there is a great scope for expanding the fish export trade on our coast, if fish canning industry is also started on proper scientific lines.

(b). Cattle.—The Indus valley is famous for its bulls from times immemorial, e.g. Mohenjo Daro relics. The geographical conditions here are ideal. In such a dry region, it is interesting to find a congenial home around Karachi for the well-

known Sindhi breed of cattle. They are among the most efficient milch cattle of India, because they adapt themselves to the poor conditions of climate and vegetation very well. Bullocks of this kind have also proved to be very useful draught animals. They are a hardy and enduring type, because of the same power of adaptation in them. They are even exported to many parts of India and abroad, though this tendency of exporting shed bulls abroad may prove harmful to Sind in future.

Among these cattle, the Sindhi (Baluchi) bulls, Thari cows and buffalo bulls are the finest in the market. (See Plate XIV).

The end of the rainy season is the most suitable for calves to be born.

These cattle frequently suffer from rinder pest owing to the infection carried through water and fodder. (**Vide** Table of cattle diseases given later).

On the whole, good fodder and good bulls are the greatest necessities of the Gaushalas in our region for improving our milk supply.

(c) Sheep and Goats.—Sheep live well on hill-sides, which provide some grass. They too are hardy due to the struggle for existence in the region. The Doomba is the most prominent among them.

(d) Bird Life.—Among the commonest birds are doves, sparrows, crows and robins. They are found wherever suitable trees are grown. Some migratory birds also visit our place.

(e) Beasts of Burden.—Among the beasts of burden may be mentioned the camel, which is the most useful of all for heavy work of loading and unloading at the harbour, the donkey, the horse and the bullock.

(f) Sport and Game.—Though not quite in the neighbourhood of Karachi, there is good game for hunters in the hills. In the Kirthar Range, the fox, the wild dog, the bear and the panther may be found. There are diving birds, such as Uria, and there is good fishing in the harbour area and along the coast. During the winter months, the tanks are also full of small game.

From the name Waghodhar (Tiger's hole), it seems that there must have been wild animals existing in the neighbourhood of Karachi, but perhaps the introduction of the gun has exterminated them.

(g) Poultry.—Among the delicate animal life, fowls and ducks play a vital part in the economic life of Karachi. They need a good deal of care and trouble to rear them. Poultry breeding, therefore, is very deficient in Karachi. Some 50% of the eggs consumed in Karachi are imported from outside. In the dry valley of the Malir, in which well-water is available and green fodder can be grown, there is good scope for poultry industry on a large scale.

(2) Animal Statistics.—Separate statistics of live stock for the city of Karachi are not available, but the following table showing the live stock and poultry census of Karachi Taluka is instructive:

TABLE XI

Live Stock & Poultry Census of Karachi Taluka
(Census held in January 1945)

(a) Live Stock:

I.	**Cattle**	
	1. Bulls and bullocks	
	Breeding bulls over 3 years	414
	Working bullocks over 3 years	3,019
	Bulls and bullocks not in use	155
		3,588
	2. Cows	
	Breeding cows in milk	6,625
	Breeding cows dry	4,244
	Cows over 3 years not calved	1,747
	Cows over 3 years used for work	319
	Cows not in use	312
		13,247

3. Young Stock (1 to 3 years old)		
Males	2,720	
Females	3,446	
	6,166	
II. Buffaloes	Total cattle	23,001
1. Males		
Breeding bulls over 3 years	9	
Working bulls over 3 years	4	
Buffaloes not in use	4	
	17	
2. Females		
Breeding cows in milk	118	
Breeding cows dry	48	
Cows not calved	4	
Cows over 3 years used for work	4	
Cows over 3 years not in use	5	
	179	
3. Young Stock (1 to 3 years old)		
Male	53	
Female	68	
	121	
III. Sheep	Total buffaloes	317
Upto 1 year old	2,571	
Males over 1 year old	1,048	
Females over 1 year old	7,442	
IV. Goats	Total sheep	11,061
Up to 1 year old	5,236	
Males over 1 year old	1,936	
Females over 1 year old	21,018	
	Total goats	28,190

V. Horses and ponies

Horses over 3 years old	91	
Males over 3 years old	95	
Colts under 1 year old	12	
Colts 1 to 3 years old	10	
		Total horses 208

VI. Donkeys

Males	722	
Females	586	
		Total donkeys 1,308

VII. Camels Total Camels 2,904

VIII. Pigs Total pigs 150

Grand total Live Stock 67,139

(b) Poultry

I. Fowls

Hens	6,412	
Cocks	1,594	
Chickens	3,272	
		11,278

II. Ducks

Female ducks	138	
Drakes	76	
Ducklings	84	
		298

N. B.—The criterion chosen by the Department to distinguish between adult fowls or ducks and chickens is the ability to breed.

Grand Total poultry 11,576

(Data supplied by Director, Veterinary services, Sind)

Compared to the present population of Karachi, the total number of cattle and other animals, except poultry, is sufficient for all purposes. Buffaloes do not thrive except in the delta proper and pigs are few due to the predominantly Mahomedan population of the province. Even the demand for horses and ponies is getting less and less due to the use of motor vehicles, while for heavy work there are enough camels.

(3) Animals Slaughtered.—Usually animals not in use and over 7 to 10 years of age are slaughtered for animal food. Even cows after the birth of the fourth calf are utilised for the same purpose. Over 2½ lakhs of animals are thus killed every year as the following table shows:

TABLE XII

Animals Slaughtered in Karachi during 1943

Quarter of 1943	Sheep	Goats	Cows	Bulls	Buffaloes	Calves
1st quarter	17,390	40,346	1,255	2,222	442	2,137
2nd quarter	12,478	39,839	1,684	1,438	398	1,810
3rd quarter	17,773	41,241	841	1,433	777	1,637
4th quarter	20,134	39,596	211	531	1,726	1,158
Total for 1943	67,775	1,61,022	3,991	5,624	3,343	6,742

(Data from the Quarterly Bulletin of Public Health for the City of Karachi)

The above data include those obtained at the three Municipal slaughter houses, viz. the New Slaughter House, the Lagari and the Keamari Slaughter Houses but not those at the two slaughter houses within the Cantonment limits, viz. the Mutton and Jhatka Houses.

The fluctuations in the different quarters of the year are due to the different seasons and also the religious and other occasions for the different communities.

(4) Animal Diseases.—It can be seen from the accompanying Table No. XIII that there is a big range of diseases from which animals suffer in Sind. The climate factor is important, so also the factor of food and drink. Poxis more or less common and stomach diseases are frequent, especially rinder pest among cattle and Ranikhet among poultry. Winds and dust nuisance are also involved. Although a good deal of research in veterinary sciences in Sind has been carried on by the present Director, a well-qualified staff in his department is needed to exterminate these diseases to improve our food situation.

SECTION E.—THE HUMAN FACTOR.

1. **Interaction of Man and Nature.**—In this critical corner of Sind, where there are some favourable physical features, the interaction of man and nature has been remarkable. They have jointly made Karachi what it is today. Never in the history of any other Indian city have such few natural circumstances and human operations contributed to such an abnormal growth and evolution and in such a short time. Wherever nature failed, man has succeeded e.g. where there would hardly have been a decent village with such a scanty water supply from the Lyari bed, there is now an exceptionally rich and growing city—the pride of Sind,— only because skilful engineers have been able to supply millions of gallons of potable water daily from other sources, which were not dreamt of a hundred years ago. For this single century, Karachi has been a seaport and a warehouse, growing in size and importance, which have been increased by its value as an airport.

2. **A Prehistoric Site.**—The nearest prehistoric site is Orangi, which is about the 7th mile post on the road to Mangho Pir. Here a spring is flowing and the ground is dotted over with small chert flakes and also bits of stone, rubble and potsherds. In the words of the late Mr. N. C. Majmudar, who discovered this place: "The site, being within a few miles of the sea-shore, was, therefore, the southernmost point in Sind, upto which the extension of the prehistoric culture could be traced. Although quite insignificant looking, Orangi may be one of the links in that great chain which must be looked for in the neighbouring territory of Las Bela."

3. **Early History of Karachi.**—A great deal of darkness prevails in the early history of Karachi. Although a stray mention is made in the Ramayana about Shri Ramchanderji (after whom Rambaug is probably named) having halted here on his way to Hinglaj and Chandragup, the Hindu places of pilgrimage on the coast and in the valley of Hingol in Makran, there are no reliable historic references found. In fact, a history of Karachi is yet to be written. A casual reference to it suggests the arrival of Skylax, the Greek explorer in the service of Darius the Great, who conquered the satrapy of Sind circa 515 B.C. He is said to have sailed down the Indus from the Punjab to the sea and made the way clear for Nearchus, who utilised this water-way about 200 years later for Alexander's Haven, which

is thought to be Keamari by some historians. Due to the approach of the monsoon season, he had to halt here, till the sea and the sky were clear.

When the Arabs, under Mahommed bin Kassim, came to Sind, they actually used the road leading to Karachi from Las Bela via Mangho Pir across the river Hab. They are supposed to have halted at Malir, as the typical date-palms grow here and at regular intervals along their route through Sind. Wherever they encamped, they ate the dates and through the seeds which the soil picked up for the tree growth. However, the historians have not mentioned Karachi as their port but Debal, which is now located 2½ miles N. E. of Bhambhore. (Ref: Thesis on "Arab Sind" in preparation). There is no doubt that even if the old Karachi fishing village existed at that time, it must have been very insignificant and must have had no affinity with the Indus delta, which had to be sought by the Arab navigators for their conquest of Sind.

History, again, is silent about this port for many long centuries, until the European sailors came to India via the Cape of Good Hope. A plan of the natural harbour of Karachi was sketched by Mascall in 1774 A.D., which reminds us that the "low sandy isle of Arrian" was no other than that of Keamari and Krokala, Kroteby or Carangee (Karachi) lay further up. The Manora island is also clearly shown in this sketch. (See Plate I—Inset)

4. **Historical Geography.**—Mention has already been made about the large number of ports that were the precursors of Karachi for a number of years. The tendency was to choose a site at the mouth of one of the branches of the Indus or of a neighbouring river convenient for river trade, which was craved for by the natives of Sind. The silting up of the harbour was a curse in every case. The Ghizri-Gharo line of contact for communication is an instance in view. Tatta, too, had its heyday of commercial glory and the Portuguese had actually established a factory there. But a more stable and fruitful port on a rocky promentary was always sought for, until among the events of 1729 A.D. the first mention of Karachi is made by Naomal Seth. Upto about 1793 A.D. the Khan of Kalat ruled over the place. He then waived his right over it in favour of the Talpur Mirs of Hyderabad, who never cared for the port, as they were not in-

terested in sea trade. Pirates from Dwarka and other Cutch and Kathiawar ports harassed the trade with Karachi for a time. So also the Balooch tribes from the neighbouring hills and the rustics from the Thar desert had their share in its plunder and molestation from time to time. In short, there were troubles all around the place due to its inherent value.

Not finding any scope for merchandise at Hyderabad ever since the Kalhoras founded this new capital of Sind in 1770 A.D., Bhojumal shifted at first to Kharakbunder at the mouth of the Hab; but as it got silted up soon, he "set out in search for another spot in the vicinity, better suited for mercantile purposes, whither they might remove. The Karachi creek was preferred. There stood originally at the head of the bar about 20 to 25 huts of fishermen. The spot was then called Dirbo. There was also a pool of water close by, by the name of 'Kalachi's Kun', 'kun' meaning a deep ditch, and 'Kalachi' being the name of a fisherman. Round about it grew tamarind and "Timar" mangrove trees. This spot was selected and houses were built thereon, and everything movable in Kharakbunder was transferred here and everybody removed to Kalachi-jo-Ghote or Karachi as it was then called. The Manora bar did not exist then, but another bar above the Baba Island, now known as the "Nawa Nar" or the new bar, was used for traffic. A ridge of hills then barred up the Manora entrance."

Soon a port was constructed to make it a safer place against pirates. It was a port of "wood and mud" and foreign labour was employed. "All labourers received their wages in dry and wet dates brought down from Bahrein and Muscat. In a short time a goodly port was raised and mounted with cannons, brought from Muscat. The port wall included an area of 60 to 70 jirabs (a jirab equals ½ acre). The port had two entrances —the one facing the west called the Khara Darwaza or the gate leading to the salt water, the other facing the north-west was called the Mitha Dharwaza i.e. the gate leading to sweet water. All people lived within the fort which was on the outside surrounded by a jungle of timar and thorny thuar bushes."

A lucrative trade was then carried on between Karachi and Bahrein, Muscat and other places. Seth Bhojumal died in the 1781 A.D. but Karachi went on growing as a trading centre after him.

(1) Earlier Settlement.—Not that there was no ancient town on the present site of Karachi. Naomal in a letter to Sir Bartle Frere wrote in 1869 about such a settlement as follows:—

"Between Camp and Clifton there is a hillock surrounded on all sides by marshy ground. On this elevated spot there originally stood a goodly town with pucca houses. The town was built by King Dalurai. To the north of this town and between Clifton and Keamari ran the (Chini Nar) China Creek. At tide time the sea water flowed into the Camp. All kinds of country vessels found access to the town through the China Creek. Between 400 and 500 years ago, the town was in flourishing condition and commanded a good harbour and ample trade. The inhabitants of the town drew their supply of fresh water from the Rambaugh tank and from a huge well in a garden to the north of the camp, which is now known as the Commissariat Well. I remember to have seen, when ten to fifteen years of ago, ruins of numerous pucca brick houses. Poor people used to visit the ruins during the rains and bring away to my personal knowledge small articles made of gold and silver. I had pointed out the spot to you, which you will doubtless recollect well. The British Government have built upon the spot a small stone house." According to the author of the some of these Memoirs, even in the neighbourhood of the present city of Karachi, there were attractive spots for country crafts to take shelter and to trade with ports on the Indus river. "I had also related to you a brief account of Waghudar, which you had noted down at the time. Waghudar was a famous town about 250 to 400 years ago, the country around Waghudar was under the sway of the Rajputs of Jodhpur. There lived in the town of Waghudar a wealthy merchant Sheth Bhudumal by name, who has built his residence with a citadel. Springs in the hills and the Malleer river supplied fresh water to the town. During the monsoons, when the passage by sea was impracticable, all country boats, coming down the Indus from Multan, Bhawalpur and New Sukkur, enter the Bajhar and find their way to Waghudar to unload their cargo and grain."

The first British attack on Manora was made in 1834, when the Sindhis fired at H.M.S. "Wellesley" a British trooper and again in 1839, when the Bombay Army actually landed at the port for forther inroads into the Indus valley, Afghanistan and Baluchistan.

But before this, the Indus river was surveyed by several British experts such as Heddle, Carless and Burns. Under the pretext of sending His Majesty's horses and a heavy carriage, as a gift to be given to Ranjit Singh, Burns had made an extensive Indus river survey. Other surveys were made in 1838, when Lt. Carless examined the harbour of Keamari, about which he wrote: "About 8 years ago, the harbour was situated five or six miles further to the west than its present position, at a spot now occupied by a large and shallow lagoon separated from the sea by a bar of loose sand and at that period it was generally known by the name of Auranga Bunder." This old harbour can be identified with Ghizri Bunder and the road which led to the Town can also be traced on the survey map.

That the earlier settlers found the natural conditions in the locality very favourable, can be seen from the following report of Sir Frederick Maitland, dated 5th February, 1839:

"At this place there are a number of wells, with abundance of excellent water for all purposes, many of them in gardens. The water is generally within 10 or 12 feet of the surface. On this point we have been most agreeably surprised, as we have been informed that the water was bad at Karachi. The harbour is excellent, in which vessels may ride at all seasons of the year, quite safely and such a port in my humble opinion, should be retained as long as we have troops in Sind."

When the harbour of Keamari was actually occupied, an extensive trade was opened with far-off places such as Bandar Abbas, Zanzibar, Malabar, Bombay and Kathiawar. All ships were, then, made of bamboo wood, kept together with coir rope. The population of Karachi, when the British took possession of the place after the battles of Miani and Daba in 1843, was only about 10,000 souls.

The Old Town itself was insignificant. Mud being the cheapest material found, it was a town of mud houses with nearly everything made of mud.

(2) Pre-British Conditions of Trade.—An idea of the trade carried on before the British conquest of Sind and the establishment of Karachi, as the new capital, can be gathered from the following table, given by Mr. C. L. Mariwalla.

TABLE XIV

Pre-British Trade Statistics

EXPORT TRADE		IMPORT TRADE	
Commodity	Value in Rs.	Commodity	Value in Rs.
Ghee	1,70,000	Sugar (Bengal, China, Manila, Batavia)	50,000
Wool	3,50,000	Coarse Sugar (Malabar)	35,000
Gogur (Gum)	12,000	Pepper	48,750
Mimgeet (Madder)	45,000	Cardamums and Spices	10,500
Raisins	32,000	Silk 1st (Bengal, China)	1,20,000
Jeerah (Seed)	10,000	Silk 2nd	1,28,000
Indigo	12,000	Timber	10,000
Wheat	67,800	Cotton yarn (England)	20,000
Fish (Shark)	30,000	Ivory	64,000
Opium	16,00,000	Copra	25,000
		Tin	17,000
		Cotton (Gujerat)	37,000
		Dates (Persian Gulf)	30,000
		Dry dates	20,000
		Pearls	75,000
		Silk (Bombay)	3,00,000

An interesting feature of the inward trade was the importation of slaves from Africa (Sidees) and Hubsees (Abyssinians), to the value of some Rs. 1,20,000. It will be seen later on how the present trade of Karachi has grown several hundred times in value in certain directions.

5. Early Improvements.

(1) Harbour works.—The first thing for the British to do, as a sea-faring nation, was to improve the natural harbour.

In 1830 when Charles Masson visited it, it was well kept by the rulers, though not as well as it could have been. "The harbour is spacious and commodious," he wrote, "and I believe the only one on the coast, where security is found from every wind and from all weathers. A cruiser of the Company has ventured into it, and I learn that ships of war of the Prince of Muskat have frequently entered it. The entrance is well defined,—to

the left or west having an abrupt hill, surmounted by a stone-built castle called Munnerroh,—to the right or east, in a line therewith are six insulated rocks, and beyond these, the low sandy beach of the mainland. The rocks are surrounded by sand banks visible at low water; to avoid those on steering into the harbour it is necessary to keep well in with the hill on the west, where there is a channel with four fathoms water—and this depth continues for about three quarters of a mile or to where the doonghees and other vessels belonging to the port anchor,—the town being still distant about a mile, the sea extending nearly to the walls."

In 1843, when Sind was annexed to the Bombay Presidency, Karachi was made the capital of the province and the development of the harbour was soon undertaken by the Government. Sir Charles Napier took a personal interest in it and in 1847 when he actually left the shore of Sind, a monument, made of Aberdeen marble in the shape of an obelisk, was raised in his memory near the Napier Mole, which was the first step in the improvement of the harbour and the depth of the stream. The inscription on this monument reads thus:

"From this spot on the 1st December 1847 was fired the farewell salute to His Excellency Lieutenant General Sir Charles Napier, G.C.B., on his retirement from the Governorship of Sind, being the extreme point to which at that date wheeled carriages had ever passed along this bunder, a work planned and executed under the Government of His Excellency and was first completed at the date of his departure from this province. Erected 1853. Rebuilt 1901."

The following were subsequent improvements made in the harbour:

1858. Docks were suggested on the west of the Napier Mole, which also provided with an opening near the Native Jetty, to reduce the brunt of the sea waves in the harbour.

1861. Keamari Groyne, 8,300 feet long, was commenced to lengthen the Napier Mole but was built of earth.

1864-65. The East Pier and the China Creek Bridge were constructed.

1870-73. The Manora Breakwaters in continuation of the island towards the south, 1500 feet long, to drown the sandbar in front of the harbour and to deepen the current.

1880-82. The first ship pier (Mereweather) was completed.

As the harbour is the real heart of the city, such improvements were desirable and were continuously made, until in 1887 the Port Trust were in possession of Keamari as a first-class port with the following facilities: Anchorage for three ocean-going steamers, moorings for eight ocean-going steamers, Mereweather Pier for one ocean going steamer, Napier Mole and Boat Wharf for country crafts. Other wharfs such as the West Wharf, a light house, oil piers, a dry dock etc. were gradually added, until today the harbour boasts of 17 east wharf berths, 20 moorings for ocean-going vessels, 4 West Wharf berth, import yards, a sea-plane base, a coasting steamer wharf, a Commissariat Wharf, a Bulk Oil Pier, and also accommodation for a British Naval Base to be established whenever required. Vessels drawing 27 feet at the lowest tide can enter the harbour now, although dredging has to be done continuously to the extent of nearly 2,000,000 tons of material annually.

At Manora itself there are now 5 piers, a graving and other yards. Between the West Wharf and the Napier Mole, the channel is about 500 yards wide and 1-3|4 mile long, while between Manora and the Keamari Groyne, it is about 1000 yards wide and 1-1|2 mile long. Among other principal landing places are Juna Bandar (Native Jetty), Napier Mole, Boat Wharf and Railway Wharf.

Since 1912, some reclamation works also have been carried out by the Karachi Port Trust and several square miles of land have been reclaimed from mangrove swamps surrounding the harbour, by means of intensive dredging in the harbour proper and dumping the dredged material into the swamps adjoining the West Wharf.

A sure way of reducing silting in the Keamari harbour would be to divert the course of the Lyari in such a way that its deltaic deposits may not enter it anywhere.

Sind was separated from the trammels of the Bombay Presidency in 1937. Since then it has found new life in every aspect of its life.

The World War II has stimulated the development of the harbour especially in the region of Chinna Creek and works have been constructed for the establishment of merchant navy clubs and training schools for the Royal Indian Navy.

The total assets of the Karachi Port Trust, who are the guardians of the harbour, are nearly six crores of rupees now. (See Plate XIII).

(2) Town-planning.—The city has grown around the Old Town rather haphazardly and, except for the Sadar and Civil Lines areas, there is no good system of town planning adopted. The old requirements of settlements in Sind were (1) safety from enemies, (2) protection from heat and cold and (3) precautions for food, water and business. Hence the selection of the site of the Old Town, the curvature and narrowness of the streets with the central position of the Junna Market. There is not a single main street or road throughout this area. With the growth of Karachi's population, there has been no corresponding increase in housing facilities for the thousands of workmen and workwomen, who drudge daily at the wharfs, in the markets and in the few industries that have been already started. Mr. Mirams, Consulting Surveyor to the Government of Bombay, in his Report on the Improvement of Karachi complained about this lack of planning. Mr. Linton Bogle, Chief Engineer of the Lucknow Improvement Trust, has endorsed the view in his book on Town Planning: "The congestion in the Old Town, where forty eight per cent of the population lives in single rooms, each occupied by six or more persons, is appalling, that the whole of this district is so shut in by warehouses and offices that expansion is impossible and that fresh sites for warehouses and factories are urgently needed. No municipality could be satisfied with this." The greatest trouble is that it is not **possible to expand it in any direction here,** as it is shut in on all sides by godowns, offices, etc. The result is undue congestion, insanitary conditions and ill health. There can be no natural life within such an ill-conceived artificial city limits. The streets are narrow and irregular and quite a number of them are badly made, so that the alignment of houses is generally north-south and not east-west, as is desirable in a city like Karachi.

Before the continuous growth of the entire city within the Municipal limits there were detached and semi-detached colonies around a number of water tanks, such as Ratan Talao, Run-

chore, Garikhata, Lyari and other areas. As more and more people came to stay in town, the intermediate spaces between these sub-urban centres were filled up indiscrimately and without a sufficient number of "lungs" and thoroughfares provided for the future of Karachi. (See Plate III-B). The result is that vigorous policy of city improvement and development will have to be followed by the Municipality very soon.

According to the Census Report of 1931, Karachi is "a most irregularly shaped city, continuously undergoing changes." It has no fixed wards on account of its expanding nature, much space for it being available in the vicinity almost on all sides. In this respect Karachi remains a unique city growth. Mr. Sedwick in his Census Report of 1921 similarly remarked: "Karachi is a mushroom city, ever expanding over a tract of sand, its edges submerged for extensive distances to different depths at different states of the tide. There is a complicated Cantonment boundary in the heart of the municipal area, a second smaller cantonment at Manora, several outlying places like Baba and Bhit, of undefined extent and only partially under municipal control and numerous distant patches of irregular shape and size like the municipal quarries." Thus the already confused state of the city has been more confounded by the presence, within its limits, of the military areas, controlled by the military authorities. The city cannot expand on this side and its growth is thus stunted. A large area of land has been occupied by the Balooch Regiment grounds and the Napier Barracks side by side with the Soldier and Sadar Bazars, built for giving amenities of life to the troops. Where such military lands e.g. the Artillery Maidan, have been restored to the city in recent years, the control is in the hands of the Estate Board again, so that within a stone's throw there may be three authorities to control and to administer the development. In some streets actually one side is under the Municipal Corporation, while the other under the Military or the Estate Board. Towards the south and south-east also, the city's growth is thwarted by the unnatural course of the N.W.R., the Thole Produce Yards, the Timber Yards and the Reception Yard.

The orientation of habitable quarters in the Sadar Bazar and neighbouring quarters is mostly north-south and the streets are wide. There are sufficient open spaces also allowed, so that it is possible to make provisions for parks, playgrounds and wel-

fare centres in these favourable parts of the city. The Depot Lines, the Commissariat Lines and the Arsenal all cater for the Military again and are built on proper sanitary lines.

A scheme of colonisation was introduced, about 50 years ago, for the more prosperous peoples and, as a result of this, two colonies have been built, one known as the Cincinnatus Town for the Indian Christians, adjoining the Soldier Bazar, and the other called the Frere Town for the upper-class Indians and Europeans towards the eastern side of the city. Another small colony has also been established near Bath Island which is, however, partially reclaimed from the backwaters of the Chinna Creek. Other excellent colonies, e.g. Katrak Parsi Colony, Amil Colony etc. have sprung up on co-operative housing society lines, along the Bunder Road Extension, though as a ribbon growth.

Regarding the general planning of these new colonies, which have come into being so rapidly, it can be said that they have the advantages, over the old city quarters, of the following nature: (1) higher ground levels (60 to 70 feet), (2) a uniform trunk road, (3) ample open space and hilly scenery, (4) good water supply, and (5) drier climate.

An excellent example of re-planning for some of the congested areas of the Old Town is Nayabad, which has been built in the south-west of Baghdadi Lines for the benefit of the labour class and on the co-operative lines, though it is hard for the people to break through their old ways of living and leave their ancestral homes in the city itself for such new quarters. (See Plate III A).

(3) Drainage and Disposal of Sewage.—Crude cesspools were used in earlier years for the collection of the city sewage. Today, although the total area of Karachi city is so vast, the population is confined only to about one fourth of it. Again, only a little more than half the populated area is at present drained. More than two thirds of the population are concentrated to only about one third of the populated area, largely lying on low and uneven ground. Thus the problem of drainage has always been difficult for the city engineers to tackle. We have seen that nearly half of the drained area of the city is flat and low-lying and it is necessary to lift the sewage by means of ejectors, working the sewage into pipes and leading it to higher levels.

The area is divided into 28 zones, each of which is provided with such an ejector at the lowest point, to which the sewage is first allowed to enter by gravity through sewers of small dimensions. From this point, then, it is ejected by compressed air and through rising mains to the pumping station situated at Barnes Street, from where again, it is pumped through cast-iron mains and discharged into the sewage farm, 800 acres in extent, on the right bank of the Lyari on the way to Mangho Pir. This system, called the Shone hydro-pneumatic system, was introduced in 1886. It took the Municipal engineers nearly two decades to construct it, but it is now found defective, as has been reported by the Chairman of the Karachi Joint Water Board: "It keeps sewage in all this area under pressure and many times there have been bursts leading to insanitary conditions in many parts of the city." Even the pipes, the drainage capacity of which was meant for a population less than 1/3 of the present, have been affected by the corrosive action of the sewage and they burst also on this account. The whole drainage system, therefore, needs re-modelling and overhauling.

Due to the low levels in the southern parts of the city, it is not found possible to pump the sewage into the sea, as is done in Bombay or Rangoon. The present sewage farm beyond the Lyari may be at present sufficient, but additional farms will be necessary, as the city grows in size and population. Another small sewage farm already exists near the Parsi Tower of Silence, and the sewage from the civil lines is pumped upto it. Fodder is mostly grown at present in these farms for grazing cattle.

(4) Water Works.—As this subject is the most important for the life of the city, it has been treated separately at the end of this Section. The geological aspects of it, however, have been already treated in Part I Section F. Several gifted engineers have given their share in the evolution of a system of water supply, which is unique in the history of Indian cities.

(5) Lines of Communication.—There are about 150 different roads, streets and cross roads with the total mileage of 190 in the whole city at present. Most of them are asphalted and excellent for motoring. The longest of them, passing through the whole length of the city from the Keamari harbour to the New Jail, is the Bunder Road with its Extension.

Other main roads are:

(a) Running N.E.—S.W.

Lawrence, Frere, McLeod, Queen's and New Queen's Roads.

(b) Running N. W.—S.E.

Mansfield Street, Frere Street, Somerset Street, Garden Road—Elphinstone Street—Bonus Road, Victoria Road —Clifton Road and Kutchery Road.

The main trunk roads are the following:—

The Sehvan Road, Mangho Pir Road, Mauripur (Hab) Road, and Drigh Road—Malir Road leading to Hyderabad.

TABLE XV

Road Measurements

Road.	Length.	Breadth (Average)	Footpath (Average)
Bunder Road with Extension	6.7 miles	90 ft.	9—18 ft.
Lawrence Road	3.5 miles	60 ft.	12—12 ft.
Garden Road—Elphinstone Street—Bonus Road	2.3 miles	60 ft.	9— 9 ft.
Victoria Road—Clifton	3.7 miles	40 ft.	9— 9 ft.
Frere Road	1.8 miles	47 ft.	8— 8 ft.

The main tram routes are only three in number:

Keamari—Market—Bunder Road—Sadar.
Sadar—Soldier Bazar—Cantonment Station.
Gandhi Garden—Lawrence Road.

The Bus routes are also too few for a city of this size; the chief one, serving the colonies on the Bunder Road Extension, is Wood Street—Jamshed Road. An efficient bus service to distant satellites, such as Clifton, Ghizri, Keamari, Mauripur, Mangho Pir, Drigh Road and Malir, is most essential for a city of this size.

The suburban railway caters for the Keamari, Mauripur, Karachi City, Karachi Cantonment, Drigh Road, Malir and Landhi railway stations; but a railway along the length of the Lyari river will be soon required, as the city develops. It will have to join the present line at Malir.

6. **Population Problems.**—Karachi had only 56,753 persons living in it in 1872, but with an expanding and attractive harbour and owing to other favourable physical and natural circumstances, it has had a phenomenal rise in the population, as shown in the following table:

(1) Growth of Population

TABLE XVI

Growth of Greater Karachi

	Karachi proper	Greater Karachi (with suburbs)	Rise %
1881	68,322	73,560	....
1891	98,195	105,199	43.0
1901	108,644	116,683	10.9
1911	140,511	151,903	30.2
1921	201,691	216,883	42.8
1931	247,791	265,565	21.5
1941	359,492	386,655	46.5
1945 (Estimated)	....	535,000	38.3

Between 1881 and 1911 the population doubled itself, then again between 1911 and 1931, there was a similar growth and it appears to be so again by now.

This increase in the population of Karachi in 70 years, with the percentage rise of nearly 600, has been rightly characterised as "one of the most striking features of the census history" of the whole country. The percentage rise of 46.5 for the last decade (1931-41) is the highest decennial rate ever recorded. The present population calculated by arithmetic progression must be 400,000, but the Rationing Officer has showed it to be 5,35,000, from the number of ration cards issued! The prospective population at this rate in 1981 may exceed 1,000,000. This is so, inspite of the fact that the whole province of Sind is sparcely populated, the density of it being hardly 85. (See Plate VII B).

(2) Variation in Population.

TABLE XVII

Variation in 3 Decades

Greater Karachi			Variation		Net Variation
1921	1931	1941	1921-31	1931-41	1921-41
216,883	265,565	386,655	+ 46,682	+ 1,23,090	+ 1,69,772

The total area of land occupied was 6,434.69 acres in 1921, 25,150.07 acres in 1931 and 27,954.24 acres in 1941. It appears that this area is not sufficient now for all the people, who are permanent as well as temporary residents of the city and expansion is desirable.

(3) Scarcity of Females.—As is typically the case with the whole of Sind, the proportion of males and females varies from decade to decade. There is, indeed, a scarcity of females shown in all decades:

TABLE XVIII

Variation of Male and Female Population

Year	Males	Females	Male variation 1921-31	Female variation 1931-41
1921	133,084	83,799	....	....
1931	156,120	107,445	+ 23,036	+ 23,646
1941	222,803	163,842	+ 66,683	+ 56,407

(4) Immigration.—Commenting on this abnormal growth of Karachi's population during the past decade and considering the various factors that have contributed to it, Mr. Lambrick gives the following reasons:—

"1. Equable climate, 2. Freedom from congestion, characteristic of most cities, 3. High standard of public health, 4. Gain in permanent settlement from immigration, 5. Extension of the Barrage irrigation, cultivation and trade."

Among other special reasons, he states the following:

In 1936 Karachi became the Headquarters of a Provincial Government and many new Government offices were opened. Consequently, there was a boom in building development of the Artillery Maidan Quarter and other areas. Karachi also took the first step towards industrialisation by opening some new factories, reorganising the fishing trade etc. The clearing and forwarding business, which is the main occupation in the city, also increased by leaps and bounds and business agencies were started. Hope is expressed by Mr. Lambrick that this tendency of Karachi to grow will not be slackened in future. "There seems to be no reason to suppose that these factors in the growth of Karachi's population will cease to have an important influence in the next ten years. On the contrary, others are likely to develop."

An idea of the influx of people into Karachi from the various parts of Sind and outside of Sind and of the permanency of migration can be obtained from the following data:—

TABLE XIX

Migration of Population.

Region of Birth	Population per 1000 of whole population	No. of females per 1000 males
Karachi district	480	753
All other Sind districts ..	145	637
Punjab and Delhi	84	621
United Provinces	43	662
Central Provinces	33	679
Northern Division	28	718
Ratnagiri	13	491
N. W. F. Province	8	346
Bengal	5	464
W. I. States Agency	3	928
Europe	3	858
Baluchistan	1	824
French and Portuguese settlements in India	1	83
Rajputana	...	667
Other Asiatic countries ..	...	1,176
Elsewhere	153	626

(Census Reports, 1931)

Thus the supplies are mostly drawn from Sind i.e. nearly 62% and the ratio of females to males is favourable for a permanency of settlement. In Bombay, on the other hand, only 25% of the population are "home-born".

(5) Density of Population.—Within the city limits, the density and distribution of the population are very uneven, as is evident from the accompanying Table No. XX.

TABLE XX

Density and Distribution of Population

Name of Quarter	Area in Acres	Number of Houses	Houses per Acre.	Persons	Male	Female	Persons per Acre.
Karachi City	27,954.24	93,247	3	386,655	222,803	163,852	14
1. Old Town	29.90	2,431	81	11,794	5,919	5,875	393
2. Napier	39.52	2,957	75	12,025	6,383	5,642	301
3. Ramswami	40.49	3,129	78	11,134	6,200	4,934	278
4. Ghulam H. Kasim	57.70	3,579	62	14,838	8,283	6,555	256
5. Market	32.90	2,021	61	8,416	4,696	3,720	255
6. Bunder	24.63	1,344	54	5,371	3,574	1,797	215
7. Tahilram	29.96	1,738	58	5,784	3,207	2,577	193
8. Runchore	209.17	9,531	45	37,172	20,790	16,382	177
9. Soldier Bazar	15.98	610	38	2,755	1,554	1,201	172
10. Lawrence	105.49	4,476	43	17,259	10,136	7,123	164
11. Wadhumal Udharam	91.37	3,236	36	13,788	7,345	6,443	152
12. Saddar Bazar	87.92	3,180	36	13,305	7,447	5,858	151
13. Baba Island	13.39	291	22	1,393	723	670	107
14. Serai	162.01	3,854	24	16,256	10,062	6,194	100
15. Bhit Island	9.00	185	21	849	439	410	94
16. Preedy	71.40	1,945	27	6,264	3,563	2,701	88
17. Rambaugh	190.91	3,385	18	14,858	8,395	6,463	78
18. Lyari	1,322.72	19,103	14	81,768	43,484	38,284	62
19. Artillery Maidan	214.04	2,132	10	11,699	6,355	5,344	55

20. Ghizri	27.95	269	10	1,390	743	647	49
21. H. Vishindas	76.68	866	11	2,917	1,839	1,078	38
22. Tata Naka	45.09	353	8	1,358	752	606	30
23. Civil Lines	201.85	2,587	13	5,103	3,211	1,892	25
24. Jamshed	429.00	2,167	5	10,306	5,656	4,650	24
25. Lea	62.03	298	5	1,431	759	672	23
26. Keamari	737.36	3,380	5	14,242	9,438	4,804	19
27. Frere Town and Bath Island	149.39	1,044	7	2,466	1,500	966	16
28. Garden West	350.30	988	3	3,522	2,071	1,451	10
29. Garden East	757.00	2,012	3	7,729	4,207	3,522	10
30. Area	694.10	2,278	3	6,541	4,119	2,422	9
31. Manora Cantt. (Civil)	321.26	596	2	2,533	1,541	992	8
32. Railway	116.08	278	2	847	636	211	7
33. Clifton	119.94	359	3	753	459	294	6
34. Quarry No. 1, 2, etc.	67.90	106	2	310	161	149	5
35. Scattered Hamlets	193.15	274	2	972	506	466	5
36. Shampir and Goth Md.	103.00	124	1	475	247	228	5
37. New Jail	448.00	215	2	1,201	1,035	166	3
38. Trans Lyari	4,078.27	2,396	1	8,397	4,378	4,079	2
39. Queens Road	156.60	102	1	238	156	82	2
40. Bunker Island	4.34	....	..	6	4	2	1
41. Karachi City (Civil)	2,030.57	2,109	1	5,854	3,273	2,581	1
42. Mauripur	6,876.00	629	..	2,560	1,508	1,052	0
43. Drigh Road Cantt. (Civil)	7,159.88	690	..	2,881	1,883	998	0
44. Military Cantt.	....	....	..	15,895	14,166	1,729	0

(Census Reports, 1941)

The table is prepared in the order of decreasing density and indicates the lines, along which a redistribution of the population can be made. Some of the Quarters, e.g. the first six, are greatly congested, while others such as the Lyari, though wide in extent, have their houses restricted to particular areas, causing too much concentration.

However, the area of the whole city, within the present Municipal boundaries, is so vast that the density of 14 persons per acre is very meagre. (See Plate II). This situation is very hopeful for our future planning.

(6) Buildings:

(a) Residential Buildings.—Bungalows, 2,128. Blocks of flats, 2,381. Blocks of servants quarters, 1,594. Blocks of tenements, 4,214. Huts, 16,235. Blocks of flats with offices and shops, 3,147. Residential hotels, 28. Dharamsalas, 72. Institutions, 113. Others, 87. Total 29,999.

(b) Non-residential Buildings.—Places of worship, 449. Places of amusement, 406. Factories Mills and Works, 309. Offices and shops, 2,334. Godowns, garrages, etc., 2,172. Others, 376. Total 6,046.

The number of buildings, residential as well as non-residential, for such an exceptionally growing city is not quite sufficient. It works out at nearly 15 persons per building, the majority being mere huts.

(c) Distribution by Rooms.

TABLE XXI.

Distribution of Persons by Rooms.

1 or less	Over 1 to 3	Over 3 to 5	Over 5 to 9	Over 9 to 19	Over 19	Total	Average per Room
23,105	126,240	109,868	81,569	17,571	1,417	359,770	4.7

Such a distribution of persons by rooms is also unsatisfactry, for Karachi.

(d) Land values.—In the following table a comparison has been made between the values of land in the different parts of the city before and after the World War II. They differ according to the locality, ownership, size of plot, position with regard to amenities, wind direction etc.

TABLE XXII.

Pre-War and Post-War Values of Land.

Locality.	Pre-war Value. Rs. per yard.	Post-war Value. Rs. per yard.	Remarks.
Old Town ..	50 to 100	100 to 300	Congested. No restriction, no lease, no land tax, freehold land.
Civil Lines ..	10 to 30	45 to 70	Spacious. Only ½ area allowed for building.
Sadar Bazar ..	60 to 100	150 to 300	No built-up area restrictions. Plots are small.
Cantonment ..	3 to 5	10 to 15	No ownership of land. Spacious. Big plots of 3,000 to 4,000 sq. yards.
Artillery Maidan ..	25 to 50	60 to 100	Open plots of 800 yards available with certain restrictions of building.
Soldier Bazar ..	20 to 30	60 to 100	No restrictions. Small plots and shops possible.
Garden Quarter ..	5 to 8	15 to 20	Building restrictions on ¼ area only. Plots of 1,000 sq. yards available.
Bunder Road Extension ..	5 to 10	25 near Jail 40 Jamshed Qr.	Spacious and very healthy. Only 1/3 area to be built.
Bath Island, Crossing ..	5 to 10	20 to 60	Big plots, 2,000 to 3,000 sq. yds. Subsoil water conditions bad. Otherwise healthy.

(7) Communal Strength.

Strength of Communities.

TABLE XXIII.

Community.		Male.	Female.	Total.
1. Hindus	..	104,869	75,330	180,199
2. Scheduled Castes	..	6,697	5,935	12,632
3. Muslims	..	92,729	69,718	162,447
4. Christians	..	10,564	6,902	17,466
5. Sikhs	..	3,694	2,141	5,835
6. Jains	..	1,765	1,449	3,214
7. Parsees	..	1,869	1,831	3,700
8. Budhists	..	68	7	75
9. Jews	..	513	538	1,051
10. Others	..	35	1	36
Total	..	222,803	163,852	386,655

The above table shows that in the matter of communities, Karachi is a cosmopolitan city, which is a great contrast to the villages and hamlets in Sind, formed on communal lines. In the heart of the city, the Hindu merchant and labour class predominate, while the Mahomedans prefer to live on the outskirts of the city. On the Bunder Road Extension side, colonies are, however, established mostly on communal lines, though there is one actually called Cosmopolitan Colony, quite in keeping with the new spirit prevailing.

(8) Variation in Communal Strength.

TABLE XXIV.

Variation in Communal Strength.

Community.		No. of persons per 1,000 of the whole population.	
		1931 Census.	1941 Census.
1. Hindus	..	457	466
2. Muslims	..	466	420
3. Christians	..	49	45
4. Scheduled Castes	..	..	32
5. Sikhs	..	8	15
6. Parsees	..	13	10
7. Jains	..	3	8
8. Jews	..	3	3
9. Others	..	1	1
Total	..	1,000	1,000

It is, again, evident from the above statistics that the proportion of Hindus and Muslims has changed during the past decade and there is now a **Hindu majority**, instead of a Muslim one, in Karachi City. Similarly, the proportion of Muslims to the total population in Sind has also declined from 76% in 1901 to 71% in 1941, whereas that of the Hindus has increased from 23% in 1931 to 27% in 1941. It is quite likely that in future years Sind, like Karachi, may turn into a Hindu-majority province at this rate. (See Plate VIIC).

The tendency among the Hindus, living on the banks of the Indus, is to emigrate and settle in Karachi. At the same time, more Menghwars, Kolis, Bhils, Cutchis and others enter Sind from the east and the south than Brahuis, Baloochis, Punjabis and Pathans from the west and the north. This is the chief reason why there is a steady rise in Karachi in the Hindu population and a corresponding fall in the Muslim one. It is so, inspite of the fact that the scheduled castes are not included in either of the communities, but they are counted, in the last Census Report, as a separate entity. Due to the enormous growth of the total population of Karachi, the proportions of the Christians and the Parsees have decreased, but those of the Sikhs and the Jains have increased on the other hand. The number of the Jews is more or less steady.

(9) Contributions made by the Communities.—The contributions made by the different communities to the growth and evolution of Karachi are varied, according to the stage of evolution, which they have reached.

(a) Hindus.—The Hindus are, as a rule, classified as under:

Class.	Characteristics.
Brahmins.—Hindu priests.	They have played a great part in the spiritual uplift of the province. But for their orthodoxy they would have done better. Most of them are engaged in trade.
Kshatriyas.—Generally the fighting forces.	But except the Marathas in the Regiment, they are generally absent from Karachi society.
Vaishyas.—Called the Lohanas who are again divided into (1) Amils, engaged generally as officers or Dewans in Government services and are highly educated.	There is still a minor sub-division of them into Hyderabadis

and non-Hyderabadis. As high-class people, they are called Bhaibands. (2) Non-Amils, who are mostly merchants, shopkeepers and agriculturists, e.g. Shikarpuri Hindus etc.

Jats .—These are the descendents of the old Scythians, now engaged as breeders of camels, cattle etc.

Among the minor Hindu communities living in Karachi, two are well-known, viz. the Maharashtrians and the Gujaratis, whose ancestors immigrated into Sind at different times by the sea route.

The Maharashtrians, numbering about 20,000 at present, first came to Sind as soldiers in the fighting forces, e.g. the Mahratta regiments, which took part in the conquest of Sind. Others followed small trades, such as tailoring, shoe-making, smithy etc. With the British rulers, there also came to Karachi some scholars and administrators from the Bombay Government, of which Sind formed part for nearly a century. Among them may be mentioned Rao Sahib V. N. Mandlik, who studied the Sindhi language, gave his share in the preparation of the Sindhi grammar and actually published some Sindhi text books; Narayan Jagannath Vaidya, after whom the N. J. V. High School, one of the first educational institutions established in Sind in 1852, is named; Krishna Shastri Godbole, Dr. R. G. Bhandarkar, Professor Lagu and other educationists and scholars.

As a rule, this community of Maharashtrians was lacking in colonisation. They never relished the idea of a permanent settlement in Karachi and Sind and preferred to return to and die in their native place. The result was that although they lived in Karachi for a long time and even built their own temples e.g. the Mahadev Temple at Ratan Talao, they left the city ultimately. They never prospered like the Parsees, who preferred to stay in Karachi permanently. They left even their own temples in charge of the Gujarati immigrants, so that there are today some Hindu places of worship, such as Rameshwar Mahadev Temple, the Chandi Mata Temple and the Thakordwar or Ram Mandir, of which the priests are Gujaratis but some of the Trustees are still Maharashtrians.

There is one noteworthy Maharashtrian temple in the Garden Quarter on the Lyari river bank, built at a cost of Rs. 15,000

by the Kolhapur Darbar. Here the body of Chima Saheb, the younger brother of the Ruler of Kolhapur, was buried in 1887. He was transported to Karachi as a suspect in the Indian Mutiny of 1857, and was kept at first at Manora but later transferred to the Honeymoon Lodge. With him came a large retinue of some 800 persons belonging to this community from the Pabal valley in the Satara district.

The Gujaratis, who number nearly 1,00,000, came to Sind principally from Cutch and Kathiawar ports as traders and have stuck to this profession generally ever since. Other professions followed by them are smithy, foundry work, mechanical engineering, masonry and building construction.

Their temples originally belonged to the Maharashtrians as stated above. The Swaminarayan Temple on the Bunder Road, Gharikhata, is held sacred by many of the Gujarati castes, while the Hatkesh Dewal in Jodia Bazar belongs to the Nagirs. Most of the Hindu temples were first built near wells or water tanks.

The establishment of the Karachi Sanskrit Association now augurs well for the Hindus.

(b) Muslims—This community is generally divided into (1) the Sindhi Muslims and (2) the naturalised Sindhis such as Syeds, Afghans, Baloochees, Brahuis, Africans, Memons, Khwajas and Borahs. The Sindhi Muslims are a class by themselves and are, as a rule, engaged in agriculture. They are mostly Hindu converts to Islam and are a powerful sect but they still adore Hindu saints, as Sufis. The Sunnis, again, have an overwhelming majority.

Class.	Characterstics.
Syeds.	Priest settlers from beyond the Iran plateau, especially Bokhara and Shiraz. They are learned and exert a great influence on the community.
Afghans.	Pathans from the Frontier, Upper Sind and Hyderabad.
Beloochees.	A warlike tribe from the Highlands. Some are jagirdars under a feudal system, but they mostly join the military and police services. Others from Las Bela State are engaged in milk trade.
Arabs.	They are traders, from Bahrein and other places and live in Arab Mohalla at Kharadhar.

Brahuis.—These are lowlanders and now engaged in rearing camels, cattle, etc.

Africans.—Originally imported as slaves from Zanzibar and Abyssina, where there was a slave trade in Sind.

Memons.—Old Kutchi Lohana converts to Islam. Now traders and agriculturists.

Khwajas.—Lohana converts, believing in the line of Imams.

Borahs.—Hindu converts from Gujarat and Kathiawar. They are engaged in business as a rule.. Their place of worship, "Adam Mosque" is the best in Karachi.

(c) Scheduled Castes.—These are also called the depressed classes, supposed to profess no definite religion. They are mendicants or menials, engaged by the Municipal Corporation and other public bodies.

(d) Christians.—According to the census of 1941, the total population of Christians in the whole of Sind is 28,000, out of which 17,466 live in Karachi. Of these, again, nearly 13,000 are Roman Catholics who have immigrated into Karachi and Sind from other parts of India and are under the spiritual care of the Mission of the Dutch Franciscan Fathers. They are well educated and engaged in various professions, such as Government and Railway services, office management etc.

A certain number of influential Europeans, engaged in trade and Government services, are included in this group of Christians.

The Christian missionaries were the first to establish their Church and a High School in Karachi, viz: Church Mission (New Zealander) High School, in 1846. There are three other Churches, viz: the Trinity Church, the Scottish Kirk (Presbyterian) and the Methodist Church.

(e) Sikhs.—Originally a warlike race, they are now engaged in trade and industry, such as carpentry, engineering, etc. They are highly religious and are an asset to Karachi, having arrived from the Punjab. Their most sacred possession is the Granth Saheb, their sacred book.

(f) Parsees.—This community originally settled in Karachi in the sixtees and seventees of the last century. They followed the British Army, as it moved on to the Punjab and

Afghanistan, in the Commissariat Department. By dint of hard labour, religious zeal and liberal education, they became successful in business, acquired land from the military authorities at a very cheap rate and built up the greater part of Sadar and Civil Lines areas. A good number of them engaged themselves as Dubashes in the business of clearing and forwarding goods at Keamari, while others sought service in various commercial firms, banks, railways, and other institutions. In fact, business and trade were their chief occupations. Having acquired wealth, they have done immense charities and established institutions, such as poor Chawls, middle-class colonies, dispensaries, hospitals, gymkhanas, schools, health and culture centres, hotels, etc. Their best gift to Karachi is the magnificent Kothari Parade and Lady Pier at Clifton. Theirs is no doubt, a solid programme of acculturation and pioneering work, worthy of imitation by other peoples. The Karachi Parsi Housing Society Ltd. was registered under the Co-operative Societies Act 2 of 1912 and the foundation stone of the Katrak Parsee Colony was laid by Mr. J. L. Rieu, Commissioner-in-Sind on the 21st March 1923.

Import and export trade has been stimulated by the Parsees of Karachi by their business acumen, barren land has been developed on co-operative lines and for Karachi's extension, water supply, sanitation and health and administration, Parsee worthies, e.g. Mr. Jamshed Nusserwanjee, have rendered meritorious services. In the building of the Cantonment area and the Sadar Bazar Quarter, the largest share has been given by the family of Eduljee Dinshaw.

Among the prominent families may be mentioned those of Dinshaws, Minwalas, Sopariwalas, Dubashes, H. J. Rustomjees. The Parsees have suffered from excessive inbreeding and fall in birth-rate and marriage-rate in recent years.

Before the establishment of the Katrak Parsee Colony on the Bunder Road Extension, about two decades ago, there was a good population of the community at Gharikhata, where even now there is an old Fire Temple founded in 1875 A.D. in the name of Dossabhai Merwanji Wadia, although there are very few Parsee families residing in this locality now. A good number of Parsee families still resides in Sadar Bazar Quarter, which possesses the Hirjikaka Aghiari, another Parsee temple,

which was established in 1849 A.D. On one of the low hills towards the north-east of the city limits are the two Parsee Towers of Silence, in which dead bodies are exposed to the elements. The older one was built as early as 1847, although the Aramgah existed in 1842 A.D.

An advanced people well-known for their pioneering tendencies, the Parsees had the first private school established in Karachi, viz. the Parsi Virbaiji School in 1859 A.D. Barely 4,000 in number, they are really a powerful cultural force in Karachi.

(g) Other Communities.—Business and industries have attracted other communities also like the Jains, the Jews, the Budhists etc., all giving their valuable share in making Karachi as cosmopolitan a city as possible.

(10) Occupations.—In a city like this, the largest number of people is that of traders, industrialists and businessmen. Women give a very small share in the professions. Out of every 1,000 persons, 281 are male workers, 35 female workers and 684 dependents of both sexes, according to the census of 1931.

TABLE XXV

Professions Followed by People

Occupation.	No. of workers per 1000
Industry	189
Trade	172
Transport	122
Profession and liberal arts	68
Exploitation of animals and vegetation	47
Public administration	42
Domestic Service	40
Persons living on their own income	8
Exploitation of minerals	3
Unproductive	34
Insufficiently described occupation	208

With the planning of new industries, suitable to the nature of the place and the communities, there is bound to be greater industrialisation in Karachi and the absorption of those people, who are described as unproductive, unskilled and insufficiently occupied, into the class of 'industry'.

N. B.—As the Census Reports of 1941 are not as exhaustive as those of 1931, statistics from both of them have been collected to suit our purpose.

7. Conflict of Cultures.—Like the plants and animals, human beings also come into clash with one another within this region.

The presence of many different communities, actively engaged in their professions in the city and, therefore, coming in close contact with one another, has resulted in a conflict of their cultures, which is, on the whole, a healthy sign for the future of Karachi and Sind. Their interests are varied but their influence on one another is good, if it is constructive. No doubt, the initial impact in every case is disruptive and causes instability.

We have seen that the majority of the people of Karachi is 'home-born'; that is to say, over 60% of them come from Sind and the rest are immigrants from the surrounding country. The province of Sind, therefore, influences Karachi the most and the civilisation, that is being generated in the city, must be the result of the ultimate fusion of the cultures of the different peoples, if not their religions. In this respect, Karachi is Sind in miniature.

(1) Sindhian Regionalism.—The Sind region is a region, which has good natural boundaries of mountain barriers on one side, a semi-desert on another and a wide sea on the third. It has favourable communication with the Punjab through the Indus. Sind, being mainly a gift of the river itself, is now formed into a rich alluvial plain. But it is only partially protected, as the mountain barriers are not complete and through the narrow but convenient mountain passes there have flowed into the valley streams of human beings, who have played a great part in producing the common culture in its cradle for well-nigh five thousand years. With the periodic desiccation of the Iran plateau and the shifting of the Atlantic Storm Belt, many hungry and thirsty peoples came to Sind and settled in it. From the earliest prehistoric times, the Chalcolithic culture penetrated through the mountain passes. Here into the valley also came the Vedic Aryans from the north to disturb the peace and prosperity of the original settlers. The enterprising and progressive Persian race next sought this region for expanding their empire, the first of its kind in the east. Then the Greeks with their heritage of the precious Cretan culture invaded the land. They closely followed the Persians, who had previously navigated the Indus for the first time. The Greeks also established new cities and ports, such as Patala at the head of the

Indus delta, which are now no more. The Thar desert also was not wholly devoid of paths to allow the inroads of people staying in the dry regions of Cutch, Kathiawar and Gujarat —a unique peneplain, suffering from famines of crops as well as of water; and from this soft land came the soft people, the descendants of those, who inhabited these parts in former ages and who were used to peaceful pursuits of life. The virile Arabs came along the Makran coast and the famous Arab trade-route, viz. Tiz-Bela-Debal, and made good use of the river and the soil. A unique class of Haris, Hindus as well as Moslems, came into existence as a result of this conflict. Sorely disappointed with the trying conditions of the Rajputana uplands, even the Rajputs sought a shelter here. The descendants of the Scythians, the Turkhans, the Arghuns, the Kalhoras, the Baluchees, all had their chance to rule the land later on and enforce their cultures on the natives. Later still, the enterprising Europeans, the Portuguese and the British traders, came to exert their influences as well. Other native Christians, Maharashtrians, Gujaratis, Parsees and even Jains took their chance, so that altogether there are some sixteen different peoples who have settled permanently in Sind and helped to produce a mingling of their cultures for many long centuries. All of them have made a mark and left their stamp upon the land without getting themselves altogether absorbed. It has thus received stimuli for its growth and nourishment from age to age and is ever growing. Thus in Sind, we have a suitable impact of cultures and a healthy conflict of ideals, wants and differences. Such a cosmopolitan civilisation has, however, never become stagnant inside the valley, but has passed into the neighbouring valleys of the Punjab, the Jamuna and the Ganges. Sind has thus proved to be a clearing house of cultures and contributed handsomely to the All-India civilisation that is being generated at present.

Thus, we see that the cultural boundaries of Sind have been pushed back by civilised man and clannishness has been avoided to some extent. Sindhi traders have gone abroad, carrying their culture with them to distant lands by sea. Thus human actions and natural phenomena have not been separated in this region. One has reacted well on the other. A further stimulus can be given to this process by mass education and special training of the people in scientific methods of work.

(2) Products of Regional Sind—Nature allows in Sind a unity in diversity, which, though born of the conflict, is lasting, due to the very initial impact and disruption, and produces ultimately a fusion of races. Such a resulting unity is triple in its kind, viz. (a) Unity of religion, (b) Unity of language and (c) Unity of culture, which are found no where else in India.

(a) Unity of religion—Ancient Hinduism or Brahmanism first gave way to Budhism, and Budhism made it easy for Islam to cause a unity of faith, which though partial, was natural in the province.

(b) Unity of language.—The language of the people before the Arab conquest of Sind was predominantly Sanskrit. The peculiarity of the Sindhi language, which is really a mixture of Arabic, Persian and Sanskrit, is that the last letter of a word has always a vowel sound, which is not the characteristic of Semitic languages. From Sanskrit to Prakrit and from Prakrit to a corrupt form of Sindhi, this language of Sind has evolved itself. Nearly 70% of Sindhi words are derived from Sanskrit, 16% (nouns mostly) from Arabic, 12% from Persian and about 2% from Baloochi, Pashtu etc. As a result of this, the Sindhi alphabet is nearly double that of any other language and the number of letters is 54. The grammar of Sindhi, too, is Sanskrit in origin but the script is Arabic. Arabic had become the court language of Sind after the Arab conquest in 711 A.D. Through the Mahomedan priests the conversion of the people was rapid. But as the Arabs themselves were preoccupied with the political life of the land and the condition after the Abbaside rule at Baghdad was critical, Sind was neglected by the rulers. They could not pay much attention to Sind and the language was largely Sanskritised by the natives. Even the script, first adopted by the Hindus, was Devnagari, until the British government enforced the present common Sindhi (largely Arabic) script in 1853. However, the politeness of the tongue and the main vocabulary have been inherited by the people from the Aryan tongues, Sanskrit and Persian.

The varied physiographic conditons in Sind, again, have produced a number of dialects of Sindhi, the chief of which are Sarili spoken in upper Sind, Lari in lower Sind and Thari in Thar Parkar.

(c) Unity of culture.—As noticed before, inspite of the physical hindrances in the region and a very limited number of

lines of communication, a certain amount of fusion of cultures has taken place in this region. Since there is no real concentration of forces and the pressure on the population from outside is continuous, "a state of negation or Nihilism" is caused. There is no identity of any particular sect allowed. From the Iran plateau has entered orthodox Islam, but the effects of its orthodoxy is nullified by a stream of visitors belonging to the Hindu, Budhist and Jain communities from the Thar side. The Ghazni, the Ghori and the Irani conquerors, such as Tamerlane, Nadir Shah and Ahmed Shah have poured the Persian elements of culture into the cauldron. The result is that there is no caste system in Sind, no priestly or Brahmanic influences predominent, no great social evils, such as depressed classes, child marriages, widow calamities etc. Such a blending is found no where else in India. But there are a few accompanying evils still left in Sind, viz. the Purdah system even among the Hindus, backwardness among womenfolk, illiteracy and a tendency to fatalism.

On the whole, the Sindhian culture has resulted in mysticism, crystallised into Sufism, which has benefited not only the different peoples living in Sind, but also those living in the Punjab and even on the Iran plateau.

How is it that the fusion between the prominent cultures has remained incomplete? The chief reason is that here nature is still more powerful than man. While the inroad of men and materials is continuous and the Karachi harbour has now been playing a prominent part in the process, there is no powerful artificial stimulation to the process of acculturation. The province has passed through great economic crises and the political forces are constantly in disturbance. In other words, while nature here tries to be centripetal, man is still centrifugal and the result is chaotic.

But, on the whole, Sind has stood the trial of regionalism well and a common civilisation. far greater than the Indus Valley Culture, is likely to develop in future years, if man introduces some proper means of acculturation, worthy of its traditions, and quicken the cultural lag that has been created in recent years. Both the narrow provincialism and communalism are likely to vanish at the touch of regionalism. It must provide an excellent blue print for a territorial regrouping in the whole country to effect a lasting unity. Lastly, the Sind region will make a most suitable background in developing a new branch of geography in India, viz. culturology.

(3) Deaths from Infectious Diseases.

TABLE XXVIII

Deaths from Infectious and Notifiable Diseases

	1940-41	1941-42	1942-43	1943-44	1944-45
Small-pox	11 (65 cases)	13 (82 cases)	95 (296 cases)	314 (1290 cases)	40 (201(84) cases)
Typhoid	68 (300 cases)	85 (371 cases)	80 (333 cases)	.. (388 cases)	59 (266(21) cases)
Diphtheria	18 (158 cases)	17 (188 cases)	11 (125 cases)	15 (104 cases)	17 (69(3) cases)
Plague	..	..	..	..	..
Cholera	29 (53 cases)	..	1 (1 case)	..	..
Measles	71	96	28	30	12
Whooping Cough	21	16	18	22	19
C. S. Meningitis	1 (5 cases)	2 (5 cases)	9 (26 cases)	13 (54 cases)	7 (35(1) cases)
Malaria	29	40	28	37	61
Respiratory System	2,736	3,163	2,978	3,579	4,233
Pneumonia	1,242	1,811	1,630	2,165	2,625

Asthma	242	254	238	210	312
Bronchitis	405	375	467	550	531
Pulmonary T.B.	778	704	611	661	754
Other Respiratory Diseases	69	19	32	32	20
Digestive System	674	743	505	875	976
Dysentry	107	123	118	124	131
Diarrhoea including T. Diarrhoca	457	459	387	505	661
Circulatory Systems	148	218	180	162	165
Nervous system	11	21	301	552	667
Urinary system	63	80	72	(Figures not available)	
Old age	745	912	860	935	1513
Cancer	23	46	33	36	34
Child-Birth	45	54	53	49	67
Marasmas	990	1,141	389	563	620

(Data supplied by the Health Officer, Karachi Municipal Corporation)

T.B. is the worst enemy of the people. Small pox is the next, typhoid the third and so on. Inspite of the vigorous steps taken by the Health Department, the condition is not improving. The root-causes are to be traced in the dust nuisance, drinking water supply, insanitary drainage, poor clothing and diet, etc.

(4) Enervating Effect of Karachi Climate.—Extreme heat in one season and excessive cold in another with very variable rainfall and aridity must have a degenerating effect upon the human constitution. Although the climate of Karachi is more congenial than that of other interior places in Sind due to the influence of the sea, as shown in Part II Section C, such an effect is not altogether eliminated from the mental hygiene of the people. The glare of the sun, the damages done by a flood season to the drainage of the city, the ripening of the fruits of the date palms and the consequent growth of flies and the daily arrivals of passengers by air, sea and land from many parts of the world at the various Karachi ports, all have their baneful effect on the bodily and mental health of the people, living particularly in the congested, low-lying and busy localities. The danger of yellow fever, particularly if planes arrive from the African ports, is great, unless a strong quarantine is established.

It is, moreover, believed that damp and muggy weather stimulates lying and fighting, while very hot and dry weather causes nervous troubles, emotionalism, and restlessness. If the weather is too hot and dry, a deficiency of energy is caused among children as well and their education suffers at the time. Only moderately dry weather stimulates vital processes and produces good results.

Air-conditioning promises a chance of maintaining good health even in a trying time of the climate, and if it is done while constructing new buildings in the city, it will be a step towards conquering harsh nature. It will be possible to reduce lithargy and moral laxity among the pupils in schools and colleges, if the buildings belonging to them are also properly air-conditioned.

(5) Geography and Bodily Diseases.—The accompanying Table is prepared with a view to showing some geographical reasons why certain bodily ailments are common in Karachi and its neighbourhood and why certain months in the year e.g. transition periods, are more prune to sicknesses than others:

TABLE XXIX

Geographical Inquest about Human Diseases.

Disease	Geographical factors (Seasons and carriers)	Other Causes	Precautions and Treatment.
1. Pneumonia	Winter Season (Wind-borne)	Chill, infection through lower resistance power, sudden changes of weather, affection of throat, bronchial tubes and lungs.	Protection against cold weather. Ventilation improvements necessary.
2. Typhoid	Throughout the year (Flies as carriers)	Unsatisfactory drainage conditions, pollution of drinking water and food, subsoil shallow wells. Human carriers of germs after attacks.	Drainage improvement, subsoil water to be stopped; cesspools, stables etc. to be cared for. Anti-typhoid vaccination recommended.
3. Small-pox	Winter season (Germs carried by wind in scales)	Infection imported from neighbouring regions e.g. Makran. Cold spells spread the disease.	Contact to be avoided. Vaccination recommended.
4. Malaria and other fevers	Rainy season (Mosquito carriers)	Cesspools, overflowing sullage, shallow wells, waterlogging sand flies.	Improvement of drains, water supply, etc.
5. Tuberculosis	Throughout the year (Human carriers)	Urban conditions and fast city life. Overcrowding, filthiness and malnutrition.	More milk and good food, more sunshine and use of ultra-violet rays.

TABLE XXIX (Contd.)

Disease	Geographical factors (Seasons and carriers)	Other Causes	Precautions and Treatment
6. Skin diseases	All the year round (Dust borne)	Calcium-starved condition, unclean habits, shortage of clothes.	Cleanliness of body, regular bath.
7. Diphtheria	Throughout the year (Children carriers)	Infection from throat through air.	Throat hygiene. Anti-diphtheria injection recommended.
8. Plague and Cholera	Throughout the year (Rat and fly carriers)	Infection imported from neighbouring parts.	Anti-plague vaccine recommended, fly and rat killing.
9. Diarrhoea—Dysentery	Fly (Khajur) season (Fly and water carriers)	Flies from Khajur trees infect food.	Boiling of milk and water recommended.
10. Eye diseases	Hot season particularly (Dust carrier)	Glare and dust nuisance.	Coloured glasses, boric acid wash.
11. Old-age troubles	Winter	Chill and consequent respiratory and other diseases.	Flannel coverings of the body.

9. Administration.

(1) The Municipal Corporation.—The Karachi Municipal Corporation came into existence in 1853 as a Municipal Commission and ever since then, the administration of the whole city, except the Military Areas lying within its limits, is in its hands.

(a) Early History.—According to an inquiry made by Mr. C. L. Mariwala (see Bibliography), at first the town of Karachi was managed by the Collector of the Karachi district. But due to frequent ocrurrences of cholera in 1846 and again in 1850, a separate and self-governing organisation, called the Board of Conservancy, was projected in 1850.

Some of the earliest roads in Karachi, e.g. Rampart Row, were constructed by this Board. But as there were no proper funds, this Board had to be raised to the status of a Commission by the Act 26 of 1850 by the express wishes of the people, residing in the town. In those days, the main taxes, from which their income was derived, were those of Choongee or weighing rates charged at the Customs House and the wheel tax. According to the first Municipal Report (1853-54), their income was nearly Rs. 14,000 derived from the Choongee dues, wheel taxes, market fees, school fees and registry fees.

A proper constitution, representing many interests of the communities, was framed later on in 1859. Although the funds were insufficient, the Managing Committee were able to construct some more roads, wells, dispensaries etc. and to start a fine tradition, which has been continued for these 96 years. The year 1950 will see the centenary of the Municipal Corporation.

Under the City of Karachi Municipal Act of 1933, three authorities are entrusted with the work of administration viz. (1) the Corporation, (2) the Standing Committee and (3) the Chief Officer. Formerly there were only 57 members of the Corporation of Karachi.

(b) The Present Constitution.—The Corporation, under the revised Sind Act, XII of 1945, has been reconstituted to have 73 Members as under:

65 elected at Ward Elections, 1 by the Karachi Chamber of Commerce, 1 by the Karachi Buyers and Shippers Chamber, 1 by the Karachi Indian Merchants Association, 1 by the Muslim Chamber of Commerce, 2 by the Regis-

tered Trade Unions (Labour), 1 by the Karachi District Local Board and 1 by the Port Trust of Karachi.

The Mayor and the Standing Committee of 12 Members are elected annually by the Corporation from among all the members, the former particularly by rotation from among the different communities.

Elections will be held after every four years in future.

(2) Income and Expenditure.

TABLE XXX

Financial Position in 1944-45

Income	In Lakhs of rupees	Per-centage	Expenditure	In Lakhs of rupees	Per-centage
Property Taxes	24.43	39.0	General Administration	4.57	7.0
Water Supply Taxes	13.02	21.0	Public Safety (Fire)	2.12	3.0
Terminal Tax	12.32	20.0	Public Health	1.82	2.0
Mun. Properties	4.63	8.0	Medical Relief	3.16	5.0
Land and House rents	2.93	5.0	Conservancy	4.04	6.0
Wheel and Animal tax	2.04	3.0	Public Works	5.08	8.0
Interest (net)	.38	1.0	Water Supply	5.10	6.0
Other Items	2.33	4.0	Drainage	6.98	11.0
Total,	62.08	100.0	Other Properties	2.76	4.0
Deficit,	3.43		Public Instruction	7.05	11.0
			Interest Sinking Fund	13.26	20.0
			Other Items	9.57	15.0
Total,	65.51		Total,	65.51	100.0

(Administration Report of the City of Karachi.)

The above table for the year 1944-45, shows that the financial position of the Corporation is not sound. In the preceding year, however, the Corporation's income was Rs. 58.16 lakhs and expenditure Rs. 53.46, with a profit of Rs. 4.70 lakhs. After nearly a decade of prosperity, the Corporation now finds it hard to balance the budget, the rise in expenditure being due to the new Water Works, roads and also war conditions. The deficit for 1946-1947 has been estimated to be Rs. 10.93 lakds.

(3) Division into Wards and Quarters.

For administrative purposes Karachi City is divided into 8 Wards, which are subdivided into Quarters as under:

Ward	Quarters
1. Old Town,	Napier Quarter and portion of Lea Quarter.
2. Bunder,	Market and Old Jail Quarters.
3. Runchore,	and Ramswami Quarters.
4. Serai,	Rambaugh, and Artillery Maidan Quarters.
5. Machi Miani,	Lyari, Trans-Lyari, Mauripur, Moach Quarries Quarters and portion of Lea Quarter.
6. Tahilram,	Lawrence, Garden East, Garden West, Jamshed, Soldier Bazar, Souter Police Lines, Preedy, Harchandrai Quarter, and portion of Sadar Bazar.
7. Railway,	Queens Road, Civil Lines, Free Town, Bath Island, Clifton, Ghizri, Quarries, Sewage Farm, Parsi Tower of Silence Quarters and portion of Sadar Bazar.
8. Keamari,	Baba, Bhit, Shamspir, and Bunder Island Quarters.

It can be seen that these divisions into Wards and subdivisions into Quarters are not natural and need regrouping, according to the physical and homogenious conditions prevailing in them. Portions of some Quarters fall into different Wards. While some are too large, irregular in shape and unwieldy, others are too small and congested.

(See **Physiographic Divisions**—Section A, 2, also Plate II).

(4) Land Utilisation.—Ever since the granting of the waste lands in the city to the Municipality by Government in 1873, the Corporation has gone on developing and utilising them for public purposes or leasing them to the

public. Out of the total area of 71.42 square miles, 8.93 belong to the Military Cantonment and 1.62 represent the harbour works and Keamari, so that the net area available for the city proper is 61.87 square miles. During recent years, due to the War conditions, very little land has been either sold or acquired. As has been said before, the entire population has been confined to only about one-third of the available land, so that there is yet a tremendous scope for developing Greater Karachi. To give a stability of tenure to landlords, it has been found advisable to grant 99 years' leases to them, though a shorter lease is also in vogue.

Quarters, like the Lyari and Old Town, need a great deal of attention, as they are too thickly populated. The Lyari Quarter particularly is built on the alluvial flat of the lower Lyari valley. Most of the dwelling places are mere huts, some 10 to 12 thousands in number; and in the opinion of the Chief Officer, "The number of such huts have rapidly increased as more and more labour came into the city from Makran, Baluchistan etc. areas, in search of employment.....a number of horse stables, cow stables, hotels and restaurants have grown up in the quarter. Thus a certain amount of vested interest is created."

The finest building in Karachi is that occupied by the Chief Court of Sind since 1920 and built at a cost of Rs. 30,55,000, though there is no proper blending of Hindu and Muslim art here, as is to be expected in Sind.

Compared to the vastness of Karachi area, the number of gardens,—the lungs of the city,—is very small, the Mahatma Gandhi Garden is the largest, being some 40 acres in area, and has an interesting history. Originally it formed part of the East India Company's Factory, established in 1799. It contains the famous grape vines, introduced in 1893 by Sir Evans James, the then Commissioner-in-Sind, from California, and a zoo with a good collection of birds and wild animals.

There is a large variety of trees growing in it, as the soil is good and fertile. The garden is actually on the left bank of the Lyari. It is likely that much of the soil was deposited here by the river in past ages. The Burns Garden is the second best garden in Karachi. It covers about 21 acres of land and is also very old but naturally the soil is not so good as that of the

Mahatma Gandhi Gardens, although the grapes grow well here also. Both these important gardens, are on its outskirts and not in the heart of the city, unlike the Frere Hall garden, which serves the Civil Lines area very well.

In addition to these, there are roadside plantations and parks here and there for the use of the general public, but they are not many and not big enough and well-equipped.

The Victoria Museum, though it has good collections of many kinds, has no provincial outlook, while it ought to have been a repository of the best relics found at Mohenjo Daro and other pre-historic sites in Sind.

Due to the inherent dryness of the region, there are very few grazing grounds for cattle. The Moach plain on the Hab Road is the chief one, in which grass grows only after rains and plots are farmed out to cattle and camel grazers. On the whole, these grazing grounds are poor and fetch only a small income for the Corporation, viz. Rs. 11,500 in 1944-45. But dairy farms are badly needed for the city's growth. Tube-well irrigation is a remedy to be suggested in the Lyari area only.

(5) Place Names.—An interesting feature of Karachi is a large number of names of some distinguished Government Officials and several Municipal Councillors given to the roads, streets, by-lanes etc. and the tendency in some quarters is even to change them in the light of recent history, e.g. Bunder Road—Mahatma Gandhi Road. Karachi being quite a new city—compared to the hoary cities of India, these place-names are a poor index of the growth and history of the city. Very few localities bear ancient historical or traditional names. The Corporation, again, cannot be said to have exercised much discrimination in this practice, as names of some real philanthropists and heroes are not always linked with the landmarks, while those of minor persons are commemorated in this manner, e.g. the name of Sir Jehangir Kothari who donated 3-4 lakhs of rupees for the most prominent landmark of Karachi, viz. the beautiful Pier and Parade, is yet to be given to the Clifton Road in continuation of the Victoria Road.

The place names in Karachi can be classified according to their sources e.g. those given af er some geographical features, those given to professional quarters and those given after prominent personalities.

Under the first group may be mentioned the following:

Clifton from cliff, Bara Andai from semblance to a big egg, Manora from Minar, Maggar Pir from crocodiles, Lyari from lar meaning lower part, Ratan Talao from the pond named after Ratan, Malir from a sweet water spring, Mithadhar sweet water gate and Kharadhar, salt water gate.

Among the professional quarters the following are prominent: Garikhata for manufacturing carts and carriages, Kumbharwada from pottery makers' residences, Dhobi Ghat from washermen's place, Chakkiwara from mills area etc.

The following are some of the typical names, given after personages:

Name of Road, Street etc.	Named after.
Napier Road, Napier Mole, Napier Barracks, Napier Street.	Sir Charles Napier—1st Governor of Sind.
Frere Road, Frere Hall, Frere Town, Frere Street.	Sir H. B. E. Frere, Commissoner-in-Sind.
Elphinstone Street	Mountstuart Elphinstone, Governor of Bombay.
Clarke Street	Sir George Clarke, Governor of Bombay.
McLeod Road	Mr. John McLeod, Secretary of 1st Municipal Managing Committee, in 1853.
Dayaram Gidumal Road	Seth Dayaram, a great Sindhi scholar and patriot.
Edulji Dinshaw Road	Seth Edulji Dinshaw, a great philanthropist.
Burnes Road, Burnes Garden	Dr. Sir A. Burnes, the first British explorer of the Indus.
Marston Road	Major (Sir) Marston who saved Napier's life at Miani, Captain of the Police.
Merewether Tower	Col. Sir William Merewether, Commissioner-in-Sind.

Preedy Road, Preedy Street	Capt. Preedy, Head of the Commissariat and Collector of Karachi.
Mauripur Salt Works	Mr. Maury, 1st Salt Revenue Officer.
Kothari Parade	Sir Jehangir Kothari, a Parsee philanthropist and world tourist.
Willingdon Farms	Lord Willingdon, Governor of Bombay.
Strachan Road	Mr. James Strachan, Chief Engineer.
Lawrence Road	Sir John Lawrence, Commissioner.
Hardinge Bridge (Native Jetty)	Lord Hardinge, Viceroy of India.
Brunton Road	Mr. Brunton, Railway Engineer.
Mahatma Gandhi Road	Mahatma Gandhi the patriot.
Jodia Bazar	Jodia community from Kathiawar.
Ratan Talao	Ratan, a Gujarati Merchant.
Mangho Peer	Mangho saint.
Ranchore Line	Ranchore, a Cutchi architect.
Rambaugh, Ram Mandir	Shri Ramchandraji.

(6) Suburbs.—Some of the suburbs of Karachi are within the jurisdiction of the Karachi Municipal Corporation, while others are under the District Local Board and the Military Authorities.

(a) Clifton.—About 3 miles from the City under the Corporation. A flat-topped hill only about 60 feet above the sea level, but suitable for a sea-side resort. This is now called Old Clifton, while the Kothari Parade and Lady Lloyd Pier, 1,300 feet long and 15 feet wide, form New Clifton. They are separated from each other by a shallow valley. An excellent beach, stretching for more than a couple of miles, is available here

and a new road from Clifton to Keamari is projected by the Municipal Corporation; but due to the sand nuisance, it has not been completed. The Pier and the Parade (1920) are partly made of Jodhpur red sandstone and partly of Ghizri limestone. A temple, dedicated to Shiva, is located in an old sea-cave nearby, and is said to have some connection with the Kalka Devi Temple of Alore.

(b) Ghizri.—A mile to the east of Clifton with a height of 96 feet, still under the Municipality. In 1854 a sanatorium was built by the Military but was soon abandoned, perhaps due to the sand nuisance and scarcity of water. It is at the head of the Malir delta and was a port before Keamari was opened; but it has now been silted up. An old road leading to the town, still exists. There are no habitations here, except a few huts for quarrymen and other labourers. A number of Municipal, Military and private stone-quarries exist, but they are crudely worked and the stone is not inexhaustible. (See Part I, Section F 1.)

It is possible to reduce the sand nuisance on this side to a great extent by setting up permeable but rigid barriers, made of bamboo and other dry vegetation and by doing reclamation work as the military authorities have done during the War period in its neighbourhood.

(c) Drigh Road.—About 7 miles from Karachi and largely owned by the Military authorities. It has an airport, civil and military. In 1918 the first aeroplane landed here. The civil aerodrome was opened in 1938. There are excellent and well-oriented runways for aeroplanes. A mooring mast and the airship shed, which can be seen from many miles distant and which were constructed to receive the ill-fated R-101, still exist. There is also a Meteorological Observatory, which caters principally for the Air Station. There are limestone quarries in the surrounding hills and the soil is hard and rocky with no local water supply.

(d) Malir.—About 5 miles further towards the east. Can be called an oasis, lying within the dry valley of the river. It has some excellent private wells sunk into the alluvium and maintains good vegetable date palm groves and fruit gardens. Its climate is drier and healthier than that of Karachi.

New Malir, a military station established during the War, is a little further to the west.

It is under the Karachi District Local Board and claims a civil population of 2,252 Muslims and 459 non-Muslims, according to the last Census.

(e) Landhi.—About 2 miles south-east of Malir but on the left bank, is also under the District Local Board and undeveloped. Raw hides, animal bones, some lignite and gypsum mines and agricultural products are found. There are some Government farms here. Good water is secured from wells from the alluvium of the river. There is a fresh-water spring at Waghodhar, near Rehri village, which has a good camping ground.

(f) Mangho Pir.—Also called Mugger (Crocodile) Pir, about 10 miles north of Karachi. The celebrated tomb near the cool-water spring belongs to the Saint, Mangho, who was a servant of the Vizier of Kabul. There is a crocodile pool near by, in which there live several crocodiles from 2 ft. to 15 ft. long. The highest point is 582 feet. It has a population of 565, mostly Muslims, according to the last Census.

Near the hot springs, which have not yet been developed into a spa by the District Local Board, there is the Hiranand Leper Asylum, which however, cannot accommodate all the lepers, that flock to the place from different parts of India due to the efficacy of the spring. It is yet a boon to Karachi and Sind. Water supply is local but needs improvement.

(g) Mauripur.—About 8½ miles from Karachi. It is well-known for salt works, named after Mr. Maury, the first Salt Revenue Official. They were constructed in 1899 on the fringe of a lagoon. Sea water is received into shallow pans, each having some 20 beds. An embankment, about 8 feet high, has been built as a protection against high tide. A primitive method of manufacturing salt was to raise brine from wells sunk to a depth of about 18 feet alongside the salt pans and to drop it into them for evaporation. A military aerodrome has been established here during the War but it can now be profitably utilised as a Civil Air Port.

(h) Manora.—Is an island about 100 feet high, mostly occupied by the Military, and covers some 300 acres. The

light-house is about 150 feet high. A special dioptric light apparatus is used to produce 11,00,000 candle-power and there is also a small meteorological observatory. Baba and Bhit islands and Sand's Spit are to the north of Manora and are suitable for picnics.

(i) Korangi Creek.—This creek has been developed during the last War, as a seaplane base. The orientation of the creek is most suitable for a runway for seaplanes during the S. W. monsoon season and it is well protected by hills on the land side, but the waters are stormy during the rainy season.

(7) Rural Settlements.—There is a good number of rural settlements in the neighbourhood of Karachi and its suburbs. They are villages, called Goth, and the inhabitants are engaged in the business of quarrying, agriculture, cattle farming, etc. Some of the important ones are Goth Bari Khan, Goth Chhoti Khan, Kotha Hashim Khan, Goth Natha on the Malir river-side, Goth Masto, Goth Lalu Ka Khet, Goth Kesari, Goth Goli Mar, Goth Shershah, on the Orangi and Lyari river side, Gulbai near Gulbai Salt Works, etc. Most of the people living in them have huts and mud houses. Water supply is defective and administration poor. (See Plate I.)

(8) Fresh Sources of Income for the Municipal Corporation.—There are two good sources of income for the Municipal Corporation viz. the Property Tax and the Terminal Tax, if they want to usher another period of prosperity. As the finances of the Corporation are not quite sound, with the future development of the harbour, the airport, the railways and, above all, with the increase of trade, some means must be found to secure more income. A warning note was given by Mr. Jamshed Nusserwanjee in 1934, when he submitted his report on the City's water supply: "We will have to be clear in our mind that the expansion of the city of Karachi is mainly due to the fact that it is a **transit place**, pure and simple, and its trade is chiefly a passage from Karachi to other places. The population increases mainly because of that; otherwise there will be no purpose to live in the City of Karachi. Whatever contentions may have been made in the past, let it be very clear that the city of Karachi, if it must exist, has to be a transit place and, therefore, when a single city stands in that position, not surrounded by other cities, which can share in

the expenditure of such a gigantic scheme, the people of that city cannot be burdened with the expenditure of such a type and therefore an **extraordinary terminal tax** would be fair to be taken into consideration for such purposes. The people of Karachi cannot be burdened with any further taxation. It will be extremely unfair to ask the people of the city to pay, when its people's whole work is practically for other cities." Mr. Jamshed had then proposed that there should be an increase of only 6 pies per maund on grain, seed and cotton in the Terminal Tax and a tax of 3 pies per gallon on kerosene oil; but it has not yet been done. Subsequent developments of the city and the suburbs, e.g. the Air Port, show that the value of the city as a transit place has considerably increased. It would be in the interest of the Municipal Corporation, if a fresh move is made with Government to revise the Schedule of taxation and to add to the list of taxable articles, especially, some articles of luxury.

TABLE XXXI

Present and Proposed Terminal Taxes.

Article	Present Terminal Tax			Proposed Terminal Tax.		
	Rs.	As.	P.	Rs.	As.	P.
Grain	0	0	3 per maund	0	0	9 per maund
Seeds	0	0	3 per maund	0	0	9 per maund
Cotton	0	0	6 per maund	0	1	0 per maund
Kerosene oil	0	0	0 per gallon	0	0	3 per gallon
Betel nuts	0	2	6 per maund	0	5	0 per maund
Cigar and Cheroots	1	0	0 per 1000	2	0	0 per 1000
Cigarettes (foreign)	0	8	0 per 1000	1	0	0 per 1000
Snuff	0	1	0 per pound	0	2	0 per pound
Tobacco (country)	0	6	0 per maund	0	12	0 per maund

It is difficult to suggest an increase in the Property Tax at this stage of Karachi's development. But more income from the Military, Railway and other authorities can be expected, as the Corporation supply them with all the amenities. At the same time it has been proposed to allocate certain taxes to the Local Bodies, viz. Entertainment, Electricity, Petrol, Racing, Motor License fees, Manufacture and Sales Taxes.

(9) Administration of Karachi Cantonment.—The Karachi Cantonment, measuring 8.93 square miles (See Plate I) and consisting of the military areas including the Barracks, is administered by the Cantonment Board, which consist of about a dozen elected Members and is presided over by the Administrative Commandant, Karachi Station. The efficiency of the whole area is maintained by the Board, although parts of it lie quite adjoining the Municipal limits.

The average annual income is Rs. 1,30,000, while the average expenditure of the year is Rs. 1,25,000. The income is chiefly derived from rents on sites leased for buildings, fees from grazing, sales of trees, fruits, grass, earth, building stone, road metal etc.

(a) Taxes.—There is an interesting list of taxation given below:—

(i) House Tax.—5% per annum on the Annual letting value.

(ii) Conservancy tax:—

For each individual (without a family)	Per month Rs. 1-15-0
For each family resident	Rs. 3-14-0
For every house connected with Karachi Municipal Corporation drainage system	Rs. 2- 8-0

(iii) Trade and Professional taxes.—Average rates are Rs. 3|- and Rs. 6|- per annum respectively.

(iv) Dog Tax.—Rs. 2|- per annum.

(v) Conservancy for Troops.—Paid by the Military Authorities for services rendered to troops in the Station per head Rs. 8-2-0 per annum.

(vi) Municipal Taxes levied by the Corporation in the Municipal area.—General 7 %, Water Tax 6%, Conservatory Tax 3%.

(b) Roads and drainage.—The Cantonment roads are wider and cleaner than those of the Municipal Corporation.

(c) Population.—There is no agricultural land within the area.

The total number of persons according to the census of 1941, was 14,727 (civilians 5,854 and military population 8,873); but it must be considerably more today due to the War emergencies and other factors, as is also the case in the Municipal area.

(1) Births and Deaths.

TABLE XXXII

Birth and Death Rates in the Cantonment:

	1943-44	1944-45
Birth rate (per 1000)	..21.25	23.35
Death rate (per 1000)	..16.77	19.82
Infant Mortality (per 1000)	..60.70	90.11

Compared to the growth of population, the death rate is satisfactory but the infant mortality is high, as in the City itself.

(ii) Prevalent Diseases.

TABLE XXXIII

Cantonment Cases and Deaths (1944-45)

Diseases	Br.-Trops	Ind. Troops	Civilians	Total
Diphtheria	3	..	..	3
Small Pox	5	36	4	45
Measles	..	22	1	23
Mumps	4	120	1	125
Enteric Fevers	8	4	4	16
Dysentery	165	367	..	532
T. B. (Lungs)	5	21	1	27
Sand Fly Fever	97	16	..	113
Dengue	42	8	..	50
Malaria	623	3,045	..	3,668
Total	952	3,639	11	4,602

(Annual Administration Reports of the Karachi Cantonment.)

cipal zone, and transportation of infection through water, dust etc. The incidence of malaria, especially, is decidedly greater among the Indian troops than among the European ones, although an anti-malaria campaign is already in operation. The health record of the civilians is remarkably clean on the whole.

(iii). Sanitation.—The Cantonment authorities have no separate arrangements for the disposal of sewage etc. except their own tipping station and their special method of incineration of rubbish. There is no flush system here for sewage. Whenever the city is flooded due to the unusual rainfall, the sub-soil water-table rises and it is found difficult to dispose of sewage water in soakage pits and evaporation beds. During the year 1944-45, due to heavy rainfall, extraordinary pools of surface water caused the epidemic of malaria.

But such troubles cannot be avoided and it would be in the interests of the military authorities, if the entire Cantonment is now removed to Drigh Road or Malir.

(10) Administration of the Karachi District.—The administration of the area outside the Municipal and the Cantonment limits is vested in the Karachi District Local Board with a President elected by it. While 73 members of the Municipal Corporation have powers to rule over an area of 61.87 square miles belonging to them, only 21 elected members (6 from General and 15 from Mahomedan constituencies) control a vast area of 8117.83 square miles with a population of over 3,18,983 persons, according to the 1941 Census. The whole District is divided for administrative purposes into nine Talukas, viz. Karachi, Tatta, Mirpur Sakro etc. There is hardly a decent town within their jurisdiction.

(a) Income and Expenditure.—They have an annual income of Rs. 4,50,000 and an expenditure of Rs. 4,00,000 on an average.

Their main sources of income are local revenue, comprising rents on fisheries, and fees from sand and stone quarries and local rates, derived from Local Fund cess, at the rate of 15 pies per rupee of land revenue assessment. At times, there is an acute shortage of water supply in the canals, which are only inundation canals, suffering for want of a suitable barrage in Lower Sind and causing heavy decrease in the local cess. Added to these items of income are tolls on ferries and roads, markets, sale of roadside trees, etc. Government grants come to about Rs. 1,30,000, including one-anna cess on excise revenues, grants for roads, water supply and education, (Vide Administration Reports of the District Local Board, Karachi).

The expenditure consists of payments due to educational institutions, schools, Madressas, cattle pounds, medical establishments etc.

Malaria and cholera are common, though villages have their own Sanitary Boards.

(b) Water Supply.—Water supply is generally from open wells, tube wells, and tanks. Except the Malir, Mangho Pir and Sehvan roads, there are no arterial roads for the District and except Malir and Mangho Pir there are no other small towns or agglomerated villages within the District. The administration of the district begins with the Mukhi or Village Patel, who carries out the police duties, while the Talati or the Tehsildar collects the revenue and pays it to the Treasury. Over these there is the Mamlatdar or Mukhtyarkar as the Head of the Taluka. An assistant Collector is in charge of a Sub-division of several Talukas and over him again is the Collector, the head of the Zilla, who deals with the District Local Board in all important State matters.

(c) Fairs.—A number of Melas or fairs are held during the year at several places within the Karachi Taluka. Some of them are known as Chaitra Bij Mela at Manora, Shivratri at Clifton, Bakri Idd at Mangho Pir, Balev at Native Jetty, Shravan Amas at Ramswami, and Gebanshah Pir at Clifton.

10. COMMERCE.—The prosperity of the whole of Sind depends largely upon the maintenance and development of the Karachi port.

In Section E.4 under Historical Geography, we have already referred to the kind of trade, carried on by the natives in the pre-British period.

(1) Imports and Exports Statistics.—With the improvement of the harbour, indicated in Section E. 5, it was expected that both the import and the export trade of Karachi would soon expand a hundred times.

An idea of the flourishing condition of commerce in recent years can be got from the statistics obtained from the Karachi Port Trust in 1912-13 and quoted by Seth Nanomal:—

"The total shipments for 1912-13 amount to 2,183,090 tons, which constitute a record in the history of the port. The number of vessels which entered the Port, exclusive of vessels put back and fishing boats, was 3,742 with a tonnage of 2,195,904¼ tons against 3,706 with a tonnage of 1,937,305 in 1911-12. The number of steamers entering the Port was 990 against 914 in the previous year. The tonnage of steamers entering the Port was 2,049,219 as compared with 1,800,581 in the previous year. The number of vessels over 5000 tons gross entering the Port was 161, against 135 in 1911-12. Three ships of the Royal Navy entered the harbour, besides six Royal Indian Marine, and two Indian troop service transports, embarking and disembarking 15,316 troops also 73 pilgrims from Mecca disembarked and 201 pilgrims embarked."

In later years, shipping increased tremendously, until a set-back was given to it due to the War conditions, prevailing since 1939:

TABLE XXXIV

Pre-War Shipping Conditions.

Shipping	1936-37	1937-38	1938-39	1939-40	1940-41
Foreign trade vessels					
Entered number	646	709	701	632	439
Tonnage, net register	2,007,009	2,219,957	2,242,258	1,985,776	1,373,490
Cleared number	650	710	703	631	439
Tonnage, net register	2,014,365	2,230,738	2,252,356	1,983,165	1,376,144
Coasting trade vessels					
Entered number	300	272	266	212	150
Tonnage net register	461,595	435,332	446,321	358,270	247,948
Cleared, number	295	270	263	211	151
Tonnage, net register	449,581	428,380	442,024	351,162	251,328
Country Craft					
Entered number	2,833	2,937	3,105	4,449	4,071
Cleared number	2,831	2,989	3,124	4,442	4,086
Flying Boats					
Entered Number	—	—	359	285	219
Cleared number	—	—	360	284	219

(Administrative Reports of the Karachi Port Trust)

N. B.—It is to be noted here that no figures of the land trade of Karachi are obtainable from any source. Both the North-Western and Jodhpur Railways feed the city, while numerous camel paths put it in communication with the dry parts of Makran and Baluchistan as well as the Sind-Rajputana desert lands.

Before the World War II, the sea-borne trade of Karachi had increased to a little over 50 crores of rupees and now owing to the War it has extended to 100 crores of rupees.

The following table gives an idea of the tonnage of import and export:—

TABLE XXXV

Tonnage of Imports and Exports

Year	Imports	Exports	Total
1919-20	3,50,533	8,28,023	11,78,556
1931-32	7,88,244	9,63,195	17,51,439
1932-33	7,45,441	9,13,810	16,59,251
1933-34	7,23,771	8,93,104	16,16,875
1934-35	7,80,854	11,75,285	19,56,139
1935-36	8,39,854	10,15,446	18,54,931
1936-37	8,14,765	12,71,581	20,86,346
1937-38	9,28,993	14,75,934	24,04,927
1938-39	8,60,921	13,95,505	22,56,326
1939-40	8,56,324	12,78,011	21,34,335
1940-41	6,36,513	12,59,955	18,96,468
1941-42	6,68,000	15,10,000	21,77,000
1942-43	13,36,000	13,38,000 (approx)	26,73,000
1943-44	10,19,143	12,64,801 "	22,83,944

(Data from Administrative Reports of the Karachi Port Trust)

It can be seen that there was a steady rise in the tonnage of both the import and export trade upto 1937-38, when due to a slump in the trade, the non-co-operation movement and the World War, there have been fluctuations. The tendency of hoarding of goods and black-marketing can be noticed in the extraordinary rise in the imports during 1942-44.

TABLE XXXVI

(2) Imports — Nature of Imports

Commodity	1936-37	1937-38	1938-39	1939-40	1940-41	Variation of 1940-41 from 1939-40 (%R—Rise %F—Fall)
Coal (Tons)	80,311	104,546	99,887	107,599	8,413	92.2 F
Iron-Steel (Tons)	72,083	82,608	64,169	58,331	44,380	23.9 F
Kerosene Oil (Gals)	24,311,804	23,059,186	16,072,120	18,469,711	13,986,201	24.3 F
Liquid Fuel (Gals)	29,018,092	33,277,772	29,300,351	28,209,922	28,903,001	2.5 R
Petrol (Gals)	18,502,779	18,410,734	18,869,479	16,203,511	11,994,462	26.0 F
Sugar (Tons)	8,418	11,202	14,646	47,145	6,320	86.6 F
Textiles (Packages)	428,979	447,523	366,319	340,369	279,690	17.8 F

TABLE XXXVII

(3) Exports — Nature of Exports

Bones (Tons)	39,743	38,141	20,466	30,186	15,881	47.4 F
Cotton (Bales)	1,880,864	1,657,545	1,492,421	1,442,550	1,266,320	12.2 F
Flour (Tons)	103,138	112,214	122,680	124,657	120,758	3.1 F
Gram (Tons)	61,460	55,657	40,851	23,605	27,421	16.2 R
Hides-Skins (Bales)	18,335	21,149	18,604	26,471	22,332	15.6 F
Oil Seeds (Tons)	90,082	88,326	61,928	78,445	85,933	9.5 R
Wheat (Tons)	284,878	514,965	389,230	165,152	148,801	9.9 F
Wool (Bales)	123,184	89,864	132,807	121,586	89,799	26.1 F

(Data from Administrative Reports of the Karachi Port Trust)

Except in liquid fuel, there was a fall in the import of all other commodities, coal import having suffered the most, during the War period. Even before the War, there was a fall in the trade practically of other goods except sugar; the fall in the import of iron and steel and also textiles was a very happy augury before the War, for India to be gradually becoming self-supporting. The textile trade was chiefly with U. K. and Japan, while Germany supplied chemicals, drugs, cutlery etc., and a good many of sundries were received from U.S.A. and Japan.

As regards exports, there was a rise only in the gram and the oil seeds trade. Most of the European countries took oil seeds, while cotton and scrap iron went to Japan. In all other items, there was a fall, especially in that of bones, which shows that Sind has begun to utilise its own increasing raw materials, as a direct result of the World War, apart from the restrictions imposed upon shipping. Excess of wheat crops after the Barrage has resulted in the increasing export of fluor to Bombay and other Indian Ports. Mixed farming has similarly increased the export trade of hides, skins, wool etc., as seen from the pre-War statistics.

The introduction of the Pan-American Airways Services is likely to produce a healthy effect on our city, both as an air and a sea port. For the present, most of the export trade is with U. K. and U.S.A.

(4) Nationalities Concerned.—Apart from coasting vessels, a large number of vessels of foreign nationalities enter our harbour every year. During 1940-41 the following were recorded.

TABLE XXXVIII

Nationalities and Their Vessels.

Nationality	Number of vessels	Percentage.
American	42	6.7
British	376	59.9
Dutch	17	2.7
Egyptian	1	0.2
French	1	0.2
Greek	15	2.4
Italian	9	1.4
Japanese	54	8.6
Norwegian	86	13.7
Panamean	12	1.9
Swedish	11	1.7
Yugo-Slavian	4	0.6

(Administration Reports of the Karachi Port Trust)

Almost all the important countries of the world are represented in their trade with Karachi.

Besides this, pilgrim traffic to and from Jeddah is flourishing, thousands embarking and disembarking every year.

Even during a War year (1940-41), the numbers of passengers carried by steamers were 22,533 and by seaplanes 4029.

(5) Taxable Goods.—Within the city of Karachi, the nature of import trade can be gauged from the income of Terminal Tax collected by the Municipal Corporation.

TABLE XXXIX

Terminal Taxes Collected.

Articles	Revenue in 1943-44 (in lakhs)	Revenue in 1944-45 (in lakhs)
Food grains and seed (including cotton seeds)	3.08	3.42
Cotton	1.50	1.29
Grass	0.19	0.16
Sugar	0.05	0.04
Ghee Butter	0.57	0.63
Fuel (Including charcoal)	1.28	1.58
Oil and vegetable products	1.25	1.77
Hides and Skins	0.22	0.20
Wool	0.20	0.31
Timber	0.15	0.17
Tea	1.55	0.99
Other items	1.34	1.79
Total	11.38	12.35

(Administration Reports of the Corporation of the City of Karachi.)

(6) Repercussions of the Lloyd Barrage on Karachi Port. There is no doubt that Karachi has been gaining considerably in its income due to the successful working of the Lloyd Barrage for the past 13 years and more, and an increase in the export trade has taken place on its account, as the following Table indicates:

TABLE XL

Comparison of Pre-Barrage and Post-Barrage Trade

Pre-Barrage Trade (Average of 1930-31 and 1931-32)		Maximum Turnover (Peak year)		Remarks
Cotton (bales)	949,920	1,880,864	(1936-37)	Nearly 2 times
Flour (tons)	91,437	124,657	(1939-40)	Nearly 1½ times
Hides and Skins (bales)	14,470	26,471	(1939-40)	Nearly 2 times
Wheat (tons)	249,482	514,965	(1937-38)	Nearly 2¼ times
Wool (bales)	72,672	132,807	(1938-39)	Nearly 2 times

11. Industries.—In regard to industries, Karachi is just an infant. It is time the export of raw materials is restricted and some industries started locally, as far as possible.

An estimate of the possible establishment of certain industries, suitable to Karachi, has been made in Part I Section F. There being no workable minerals in Sind including coal, and, for the present, also petroleum, it is difficult to start heavy industries.

(1) Existing Industries.—Reference has been made in the same Section to the good beginning made with salt and cement manufactures on an extensive scale.

Other industries, started on a small scale at present, but requiring protection, are given in the accompanying Table No. XLII. Most of them are located on the Lawrence Road and Bunder Road Extension and are not likely to affect the health of the city to a great extent. It is expected that instead of establishing new industries within the habitable quarters, a small industrial town will be planned round about Dalmia-nagar and the water of the Lyari will be utilised for some purposes, as the Dalmia cement manufacturers have done.

(2) Possibility of a Cotton Mill.—With such an immense output of cotton and that too of a good long-staple quality, it is surprising that a proper cotton mill, manufacturing cloth, has not yet been started. At one time it was feared that the climate of Karachi was unsuitable for such a textile industry. But with the advance of science, it is even possible to "manufacture" a climate suitable for it. The manufacture of yarn re-

quires a uniform humidity of 40% and of cloth that of 70 to 80%. In drier air, the thread does not stand; but artificial humidity can now be obtained by several processes with success. In preparing a scheme for the cotton industry, other factors such as the situation of the factory, wind direction, temperature of the air, quality of water etc., have also to be considered.

(3) Fishing Industry.—In these days of "Grow more Food", the question of fishery and fishing for the Karachi coast must be considered favourably. Reference has already been made to the nature of fishing ground and marine fisheries vide Part II Section D 3. (1) (a) Sea fishing, on the Sind coast, is still in a primitive state, the annual catch per fisherman being hardly a ton or two per year, whereas the figure for Madras goes upto 7 to 10 tons per year. The total catch for fishermen is about 5,000 tons in a year and Karachi consumes nearly half of this amount. The rest forms an export trade, especially of prawns, as far as Quetta and Lahore by land and Colombo and Rangoon by sea.

There is yet a great scope for fish curing, dehydration of fish and tinning, which need immediate attention. In short, in the solution of any problem of food for daily use and special food, such as shark liver oil, Karachi fishery has a great future. (For further information on the subject, **vide** Paper on "Prospects on Fisheries and Fishing in Sind", Raisinghani and Pithawalla. **Ind. Geog. Jour. September 1943).**

(4) Flour Mills.—Karachi is well-known for flour mills, as it is the chief exporting port for an extensive wheat-producing hinterland of Sind as well as the Punjab.

There are special mills established on the Lawrence Road and flour is exported in large quantities to western and southern Indian ports, where wheat is unobtainable.

(5) Salt Manufacture.—The chief geographical circumstances which make this industry extremely flourishing are: Scarcity of rain, bright and cloudless sky, pretty high temperature, velocity of wind, favourable humidity, cheap labour and economic transport.

SECTION F.—WATER SUPPLY AND DRAINAGE

1 **Water Supply.**—A city's life and growth depend upon its water supply and from the very establishment of Karachi, this problem has taxed the minds not only of the founders and the Corporators but also of the engineers, many of whom have given their share in its solution; but the supply cannot yet be said to have been assured and for all times. Side by side with it, the problem of drainage has also been found to be intricate.

(1) Geological and Topographical Aspects of the Works.—

The geological aspects of the water works with some of the schemes proposed, have been already dealt with (*vide* Part I Section F).

In the Section of Topography and Hydrography (Part II Section B), again, further details regarding the courses of the three main rivers, which are in the neighbourhood of Karachi, have been given.

It now remains to deal with the history of the various water works and their possible improvements.

(2) History of Karachi Water Supply and Water Works.—

"The earlier history of Karachi's water supply", says Mr. Jamshed Nusserwanjee, the maker of Modern Karachi, "is a chequered one". Before the Municipal Commission was instituted in 1852, and for some time longer, private wells dug into the alluvium, within the city limits, were the only source. The Municipality, later on, increased the number of these shallow wells from 5 to 16 in different parts of the town, but mostly on the left bank of the Lyari river. Another source was the 4 or 5 water tanks, in which rain water was allowed to collect, e.g. Ratan Talao, Ranchore Talao, Nanakwara Talao, Rambaug Talao and Frere Town talao. Wells were, again, dug around these artificial tanks and water was supplied to the city through pipes.

But the quality of water, naturally, was brackish and the quantity insufficient. As the city grew in size, the Municipality became anxious to find out a more satisfactory source, which was first discovered in the Malir by Captain De Lisle in 1856. But for another 25 years or so, the actual project was not put into operation, until Mr. Strachan, the Municipal Chief Engineer, planned in 1882 a conduit from Malir to Karachi. In 1884-85 the first two wells were actually dug on the right bank of the river at mile 18 and a conduit line was laid from this point to the reservoir. One by one, then, other works were constructed, so that a whole system of Water Works was evolved.

(See Table XLIII)

The average size of the wells is 40 feet and the average depth 50 feet. Wells Nos. 1 and 2 are now practically dry due to the interference of newer wells for the whole year. Nos. 3 and 5 gave a good supply upto 1929, when No. 6 well was constructed, while No. 4 well was found to be shallow and unprofitable. Nos. 6 and 7 wells are the best of all and supplied most of the water to Karachi, until the balance was disturbed when in 1936 No. 8 well was dug and a year later No. 9 came into use. The new underground hanging galleries were giving some 15 lakhs of gallons till lately, though they extinguished the old ones. The three tube-wells yielded about 5 to 6 lakhs of gallons more of water. Pumping has been resorted to whenever necessary, so that at one time (e.g. 1933, according to an official report) Well No. 5 alone yielded 15 lakhs and well No. 6 25 lakhs of gallons per day. Thus the whole system of wells and galleries have supplied no less than 10 million gallons of water per day to Karachi for a number of years. The total cost of all the Water Works is nearly Rs. 10,000,000 (See Plates X and XII).

That even such an enormous quantity of water was insufficient for an exceptionally growing city was obvious. It was so also from the point of view of supply per head. Water was needed for more and more industrial concerns. Commenting on this aspect of insufficient supply, Mr. Jamshed Nusserwanjee stated in 1934: "We must not forget that we are supplying to the city of Karachi at present only 23 gallons per head when the ordinary supply should be 40 gallons. We are supplying only for 7 hours a day and sometimes even less and this is very unhealthy for the city. If water is supplied continually during 24 hours, though the quantity used may not increase in that proportion, it is healthy to give continued water supply from the hygienic point of view. This is an additional reason for having another source of supply."

(4) **Defects of the Dumlotte System.**— The most glaring defect of the Dumlotte system is that it has caused interference between the wells, located too close to one another and on the same bank. No sooner was a new well dug on the upstream side, than the wells, lower down the valley, were reduced in level, even though the dry-stone galleries were extended to 5,000 feet and more. No records of the levels in these wells for any length of time have been

kept by the Karachi Municipality for our comparison. All the wells are situated on the right bank and within a distance of 9 miles. As the Karachi Municipality did not own any land on the left bank, not a single well for our Water Works has been dug on this side. Every summer or dry season, there was, therefore, shortage of water supply, even though the pumping operation was carried on night and day. In years of comparative droughts as the cycle shows, the water secured from the wells was muddy and was surcharged with chlorine at the reservoirs. The depths of the existing wells were too shallow compared to the discharge by pumping. But these wells became overfull after every heavy shower of rain and the water turned cloudy, while carrying calcium and other salts both in suspension and in solution. The process of chlorination, though systematic and much improved upon lately, had the disadvantage of leaving too much free chlorine in the water, which tasted unpleasant. Chemically also the water was not perfectly pure and quite free from solids. But the severest criticism of the Dumlotte system was that it had reached the limit of alluvial supply of drinking water and some new source was to be found elsewhere.

(5) Previous Researches.—From time to time, the Municipal and other engineers have made proposals to improve the supply and some of them have also made experiments and done some useful prospecting for water.

In 1923, Mr. Measham Lea reported: "In question relating to the water supply of a large city, it is necessary that a long view of the future possible requirements should be taken, as works of large magnitude take some years to construct." He also made some experiments with new wells.

In 1925 investigations were made in the Malir valley for the Karachi Municipality by the Public Works Department with a view to realise the future possibilities. The results, ("Report of the Malir River Boring Investigations for the Karachi Water Supply"—Bombay P.W.D., Technical Paper No. II), are noted as under:—

"A very strong underground current passes through the sandy bed, the depth of which varies from 35 ft. to 70 ft."

"A large number of springs issuing from the Khadeji hills are seen lost in the sands at lower levels."

"The Dumlottee supply is not limited to the capacity of the sandy basin alone, since it receives a constant increase from fresh supplies in the form of an underground river of considerable volume, which in turn is fed by perennial springs in various parts of the Khadeji hills, 15 to 20 miles above Dumlottee."

"The subsurface water levels rose upstream at a fairly rapid rate."

"The sandy basin itself is of considerable extent, being more than 150 ft. wide and something like 45,000 ft. in length with an average depth of water-bearing sand of about 50 ft. 30% of this volume may be regarded as water in slow motion and thus there is ample water there to supply the prospective needs of Karachi."

It can be seen from the above reports that no consideration was given to the large amount of percolation water in the deeper layers in these areas.

An experiment in tapping the subterranean resources was made as early as in 1869 by Mr. J. W. Barnes, Bombay P.W.D. He made a boring about 8 miles N. E. of Karachi and reported as follows:—

"I had the satisfaction after some weeks' labour of piercing the first water bearing stratum when water ran up and overflowed the surface continuing without intermission to flow to this day."

Mr. Barnes noticed that, although the temperature of water was nearly 85 deg. F and, passing through saline aluminous shale it was brackish, yet it was useful for irrigation and he and his men on the work also used it for twelve months. He adds: "I apprehend that wherever the interior aluminous shales yield, as in the case of my borings, a continuous flow of water, we may reasonably calculate on a larger and purer yield, if the borings are continued to Lower Tertiary strata."

He gives two sections, one across Mangho Pir and the other across the land, 25 miles north of Karachi, (See Plate XI Part I) and shows that springs issue over a surface 60 to 300 feet above the valleys in their own latitudes and that while at one spot a spring is brackish or mineralised and hot, at another and almost at the same height it is fresh and sweet-watered.

At Mangho Pir a spring of potable and comparatively cool water has been detected not far from the hot spring.

The following is a complete list of bore holes for water in the Malir valley, made by the Municipal Engineers uptil 1938:

TABLE XLIV

Total List of Boreholes.

Year	No. of Bore holes	Engineer-in-charge
1920	12	Mr. Measham Lea
1921	14	Mr. Measham Lea
1922	13	Mr. Measham Lea
1930	44	Mr. J. N. Sethna
1936	1	Mr. N. J. Modi
1937	21	Mr. N. J. Modi
1938	8	Mr. N. J. Modi

The most important investigations, however, made on the hydrography of the Malir Valley were carried out by the Municipal Corporation under their Special Engineer Mr. K. R. Bhide during 1938-39. By means of a number of other trial borings, trenches etc., it was discovered that a large quantity of potable water was running to waste through the sand, gravel and boulders into the sea and that the water-table rose and fell from one time during the year to another in the years of average rainfall and independently of the consumption of the water supply through the water works. According to Mr. Bhide, the total quantity of water-bearing strata, consisting of sand, boulders and gravel free of water on 24-8-1938 from the confluence of the Mol and the Khadeji to well No. 1 i.e. Mile 18, was 3093 M. C. ft. nearly, while it was 5535 M. C. ft. on 19-7-1938. But the total quantity of water-bearing strata consisting of sand, boulders and gravels from the confluence to Well No. 1 (Confined to the River bed only) was 9861 M.C. ft. Making due allowances for absorption etc., Mr. Bhide reported (Note No. 4): "It has been shown that in an year of average rainfall, from out of the total fall of 7,000 to 8,000 M.C. ft. on the catchment, 65% i.e. 4550 to 5,200 M.C. ft. is absorbed in the soil of pervious Gaj rocks—part of which is given up in the form of springs later, 22½% i.e. 1575 to 1800 M. C. ft. is absorbed between the confluence and the Malir Bungalow—most of which flows beyond the latter point in the

next two months—unutilised, and 12½% i.e. 875 to 1,000 M.C. ft. directly flows to the sea in the form of floods. It can safely be presumed, therefore, that in a average year, at least 2,000 **to 2,500 M.C. ft. is allowed to run to waste unutilised.** This is equivalent to 625 to 780 days' supply at 80 million gallons per day or 825 to 1,000 day's supply at 15 million gallons per day! and this does not take into account some of the 65% supply, which is later available for use in the form of springs and under current."

This, however, is a very modest estimate. On an average, one inch of rain water provides about 15 million gallons of water per square mile. Now, taking the catchment area of the Malir to be about 500 square miles and the rainwater only 7 inches per year, (though the average rainfall in recent years is much more) we can estimate the total amount of water available in the basin to be over 51,000 million gallons (15x7x500). Out of this, generally 1|3 of the rainfall i.e. nearly 17,000 million gallons escape as surface run-off, leaving 34,000 million gallons of water in the superficial as well as the deeper strata of rocks. Deducting 1|3 more of the amount running into deeper strata, we have **clearly in the Malir Valley 17,000 million gallons of water flowing through the alluvium within the Dumlotte system.** But the engineers at one time drew only about 3,650 million gallons per year from the wells and the galleries out of this gigantic store and **allowed the rest of the precious water to run to waste.** The problem of problems was to stop this wastage and to impound the escaping quantity of water by some scientific methods. If this flow was even partially stopped, the water-table would rise immediately and the water would start flowing even by gravity to some extent.

(6) Investigation of Artesian Conditions.—Another point that would strike any one was to discover if there was any chance of tapping the subterranean sources, possibly storing the one-third of the total quantity running into deeper layers of limestone or lying in subterranean caverns, as is expected in such soluble rocks. The Municipal Corporation were good enough to allow a deep-bore at the confluence of the Bazar and the Malir during the year 1940 at a small cost of Rs. 20,000. This matter has been referred to in Part I Section F and the conclusion drawn from it is that the boring should

have gone deeper to secure a larger quantity of potable water from the Nari sandstones, since the artesian condition was already established thereby.

A thorough investigation of a geological nature for artesian wells has been made in other parts of India. There is a valuable contribution to this problem in the publication of the Geological Survey of India, in which an account is given of borings, such as those made in the Tertiary rocks at Gogah (Gujerat),) the alluvial deposits of the Indus plain at Sabzalkot (Dera Ghazi Khan District), and in the deltaic deposits at Calcutta. Though the author (H. B. Medlicott) did not draw any definite conclusions for want of sufficient data, he was convinced of certain indications for artesian and sub-artesian conditions in these regions. He has stated: "It is quite certain that, on the whole, they (deposits) are made up of alternations of porous and non-porous materials and in the case of river valley deposits there is a further presumption that **the bottom beds**, formed largely of the debris of local rocks, **would be coarse and porous**, while, as the deposits accumulate and spread at higher levels, finer sediment would predominate. One might travel over the plains of India, from the delta of the Ganges to that of the Indus, without finding a transported pebble larger than a pea. Accordingly, it is a matter of very wide experience that artesian springs are abundantly yielded by such recent deposits." (**Vide** H. B. Medlicott—"Artesian Borings in India," Rec. Geol. Sur. Ind. Vol. XIV Part 3, 1881).

The nuisance of fine sand choking up the pipe line in the Bazar deep bore was itself an indication of the occurrence of coarse and porous material at deeper depths yielding a profuse supply.

Dr. B. N. Dey has already suggested the Layne-Well system of deep borings **plus** sealing off saline water by means of cement seals, after his inspection of the site. One may, therefore, be quite sanguine about successful artesian wells at suitable spots in the Malir Valley.

(7) Other Methods of Improvement suggested. — Other methods, suggested by engineers to cope with the growing demands for water and to improve the supply were doubtful, impracticable and expensive. They included an elaborate extension of the present system of wells and galleries.

(a) Drawing upon the subsoil flow by putting up more wells at Dumlotte. There is the same old risk of piracy and interference in this method, and we do not think the problem of Karachi water supply could be permanently solved thereby. Besides, this subsoil source is ever dependent upon the amount of percolation of rain water in a particular year. It is possible to dig some successful wells on the left bank, but the Municipal Corporation does not own the land. It belongs to Zamindars, who would claim heavy compensation.

There is, it is argued, again, "an economic pumping level of water which cannot be exceeded in a predominating agricultural zone without loss to the Zamindars." The green belts must be preserved side by side (See Plate I).

There is a chance for more successful cross-galleries cut far into the banks to catch escaping streams.

(b) Boring tube-wells into the alluvium.—3 trial tube wells were already constructed by the Corporation and the results were not very satisfactory. The depth of the wells was round about 100 feet. It is possible that a more plentiful supply of water is available in this locality. But the danger is the usual one of losing water in the Dumlotte System and the galleries. There is also the danger of getting accumulated saline materials in the lower sandy layers, as the bore holes go deeper and deeper into the alluvium. It is possible that **in the immediate vicinity of the fresh water streams** and comparatively shallow wells in the river valleys, any saline materials in the native rocks are washed out and the gravels yield fresh water, but in deeper layers it may not be the case. Such is the case not only in the Malir valley but in the whole region of our study.

(c) Impervious Diaphragm across the Dumlotte Gorge.—As noted before, there is no gorge worth the name in the whole course of the Malir from the confluence to the sea, but in the so-called Dumlotte gorge, some 52 feet below the junction chamber where the hanging galleries and the conduit line meet, the banks of the river come closest together to the extent of 716 feet across. They are flanked here by low rocky scarps and it was thought possible to provide a special type of barrier in the underground, called a diaphragm, by solidifying the sands and filling up the rock cavities in this area by a process of cementation, so that the water would be checked and

haded up and the water-table on the upstream side would be so raised that the water would flow into the galleries and the conduit automatically for a longer time after the rains had fallen.

The construction was actually carried out in 1939 by boring holes at regular intervals in the gorge by percussion drilling and injecting liquid cement into them to a depth of 80 feet and more. 14,000 bags of cement were charged into the sands to a depth of about 80 feet at regular intervals of 6 feet or so and at a pressure of 250 lbs., across the whole length of the gorge and more. The years immediately following the construction were very lean from the point of view of rainfall. Then suddenly we had in 1944, as is usually the case with the rainfall curve in Sind, very heavy floods, perhaps the heaviest in recent times. And we noticed that even upto the end of November of that year there was a surface flow of water above the gorge, while the water table was so low below the gorge.

The undersurface Dumlotte diaphragm was perhaps the first engineering work of the kind constructed in India, under the vigilant supervision of Mr. Bhide. Our own objection to such a work, in one of the most delicate parts of the Dumlotte system, was actually shown in a special paper on 'Karachi Water Supply', published as early as in 1936 (Vide P. 10). It was not in any possibility of a mistake in the construction itself, but in the 'very nature and geological structure of the gorge'. To any sensible civil engineer, this gorge would appear to be not an ideal one for a dam. It is a slightly anti-clinal fold, denuded and eroded into a third-rate gorge by the river during flood seasons for many millions of years. The dips are not quite favourable for a dam and the depth of the gorge is very shallow, so that if a 'solid' dam had been constructed across it, there would have been many chances of leakage not only underneath the barrier but also chances for the water to flow away on the two sides of the gorge rather than raise the water table above it. It was only when Mr. Bhide convinced us that it was 'not' going to be a solid impermeable barrier throughout but only a partial one, made with a view 'to lessen the speed of flow through the sands', that we allowed it to be an experiment in prospecting for more water for Karachi. The public have always welcomed any sensible engineering scheme whereby we can prevent that tremendous wastage of water into the sea from the Malir,

water from which is far better than the supply from a stagnant and exposed lake like the Haleji Dhand. We cannot afford to neglect the Dumlotte supply altogether, as it is going to be a good mixer for our water at all times. (See the Scheme below)

(d) **A dam or dams across the Mol or the Khadeji and Impounding Reservoirs.**—This was possible only, if the rocks outcropping in the area were impervious and the dips of rocks favourable. It is to be remembered that the Gaj limestones, jointed irregularly and fissured considerably, would not offer an impervious floor, however suitable and safe the dam may be. It is hard to find a bed of impervious clay or shale for a safe reservoir, however elaborate, on the upstream side in this valley; and even if one is found, it is doubtful whether another suitable surface or subterranean dam could be built any where below the confluence and in the alluvium (Ref. (c) above) to supplement the process of impounding the flow. Experimental bore holes for the foundation of the Khadeji dam, however, have been lately made, and useful data gathered by Mr. Bhide for such a project, though the dam was suggested by Mr. Measham Lea as early as 1913. The cost of such a dam would be over Rs. 25,00,000. What is quite possible in this area is a partially solid barrier across the Khadeji gorge and others at convenient spots above the Confluence, in order to stop the rapid flow of surface run off in the first instance and to let the inflitrating water run through the sand and gravel more slowly, so that a perennial subterranean flow at a higher level than at present may be secured and the level in the galleries raised to a certain extent. But here, too, the danger of some good water escaping through the bedding planes on both sides is real. This point has been already made clear in connection with the similar impervious diaphragm across the Dumlotte gorge.

(8 **The Indus Scheme.**—There were four alternative schemes suggested in 1933 by Mr. Shete, Consulting Public Health Engineer to the Government of Bombay, mainly depending upon the point of intake on the Indus viz. (i) Intake at Head of the Kalri canal at Tatta (61 Miles), (ii) Intake at Qureshi Pir (74 Miles), (iii) Intake at Jheruk (89 Miles) and (iv) Intake at Kotri (109 Miles). All these schemes involved double pumping of water, once from the river to a high level,

away from the influence of the river floods etc., and again from the purification works to elevated reservoirs for distribution under pressure to the City. All these were very expensive schemes, costing according to estimates in 1933, Rs. 1,30,00,000, Rs. 1,80,00,000, Rs. 2,69,00,000 and Rs. 2,85,00,000 respectively. The recurring cost of pumping alone was estimated to be about 10 lakhs of rupees every year.

This new supply from the Indus, however, was proposed not as an alternative but as a scheme **supplementary to the Dumlotte supply,** the policy being "to draw as much as possible from the existing source and to secure the rest from the Indus." As we have stated before, the supply from Dumlotte has always been welcome, being partly derived by gravity in some months and by medium pumping in most of the months.

Scheme (i) was not accepted, as it was argued that the level of the river was very low at this point and the Kalri Canal flowed only for the monsoon season. Besides the river itself was not stable at this point.

Schemes (ii) and (iii) were also discarded as the intake would be similarly risky, and there were difficulties about infiltration wells, location of the pumping stations etc., owing to the nature of the surrounding country.

Scheme (iv), although practicable from the point of view of a safe intake, was considered to be too costly and therefore prohibitive. It was possible, again, only if the project of a barrage for Lower Sind across the Indus river at this point was simultaneously taken up by Government.

The matter remained hanging for some time, until the World War II brought it to a head and the Military authorities started taking interest in it for the water supply for the troops.

Quite in its deltaic stage in the Karachi district, the Indus, "one of the most unstable rivers in the world, would never really allow intake works on low and unstable banks. The river shifts its source—at times by miles and in a single season. The course of the river, was, therefore, carefully surveyed and somewhat permanent banks were found near Daduri Hills, 80 miles from Karachi. The vagaries of the river prevented its tapping anywhere nearer."

At the Daduri hills intake, a pumping station was proposed, which was to pump up the water from the river to the hills on the banks. The level of the river is so low and is so flat that two more pumping stations had to be put up before the water, which was to be conveyed through conduits, could reach Karachi.

The three pumping stations and the inordinately long conduit,—about 90 miles,—made the scheme very costly and it was thought desirable to cheapen it, if it could possibly be done.

In the Karachi district, a number of inundation canals take off from the Indus and supply water for irrigation. If one such canal, flowing towards Karachi, could be utilised for the water supply, it would save considerable expenses. But these canals are not perennial and their supply depends upon the level of the Indus, which falls so low in winter that the canal beds remain high and dry. The storage of water during such intervals is, therefore, necessary. The district also abounds in a number of shallow natural lakes, known locally as Dhunds, which merely store rain water of the locality and help to breed mosquitoes. One of these lakes, known as the Haleji Dhund, was to be designed as an artificial reservoir, from which rain water was to be excluded and into which the discharge of a canal was to be admitted. The Kalri canal luckily flowed past the lake. It was decided to give a cut in this canal to throw its water into the lake. From here a conduit was to take off, as per original scheme. This proposal of the canal and the lake would save the cost of 40 miles of conduits and one pumping station.

Due to continued draught and particularly the exigencies of the War, Karachi's situation as regards water supply grew most critical in 1942. It was, therefore, decided to take this scheme in hand immediately and execute it in the shortest possible time. **(See Plate XI)**

The scheme has now been completed in its main essentials at a cost of Rs. 1,91,00,000, jointly shared by the Municipality and the Government, both Local and Central, and Karachi has been getting water from the Indus since the beginning of 1944. The Haleji lake has been remodelled with earthen embankments on the sides, holding some 13,000 million gallons and enclosing an area of 9 sq. miles, into which the

waters of the Kalri Canal are diverted. The lake is fed from the Kalri by means of a new barnch called the Reservoir Branch, which commences to function from June till the end of August and discharges about 130 million gallons of water per day. Thus the draw-off from the lake would be about 12 million gallons per day, making allowances for evaporation, absorption, seepage etc. From the Haleji lake a gravitational conduit of masonry construction takes off and flows for 13½ miles upto the Gharo village, where the first pumping station is situated. Here the water is pumped through a cast-iron rising main to a high ridge about 3 miles away. Filtration, consisting of a set of eight rapid gravity filter-works, are situated near this ridge. It may be stated in passing that the Dumlotte water, supplied to Karachi all these years, never required to be filtered, as it was obtained in a pure state from the underground alluvial deposits of sand, gravel and conglomerate, which themselves form a natural filter. The surface waters of the Indus, on the other hand, are laden with silt and other impurities, which make filteration and purification indispensable and difficult.

The filtered water again gravitates for 33½ miles upto Drigh Road about 6 miles from Karachi. Here Hume pipes have been used for the conduit in preference to masonry construction as in the previous tract. The alignment of the conduit passes through an arid tract composed of the Tertiary rocks, sometimes bare and sometimes overlaid with alluvial deposits. Three factories for the manufacture of Hume pipes were set up in this area and ready-made pipes were transported to the site and laid in position.

At Drigh Road the water is pumped through a second pumping station to a hill near Kali Mandir on the outskirts of Karachi. Here a large Service Reservoir, with a capacity of 20 million gallons, is projected and the city is to be supplied with water from it, after the water is sterilized. It is about 50 feet higher than the old reservoirs, so that the water would be at a higher pressure and rise to upper storeys in the city and would eliminate the nuisance of hand-pumping throughout the city.

Altogether the Haleji water is lifted to a height of about 150 feet from the lake level. **(See Plate XII and Plate XI of Part I)** It can supply 12.5 mill. gallans a day for only 287 days in a year.

(a) Administration of the Scheme.—It is to be noted that the government of the Karachi Water Works, old and new, has now fallen to the lot of the newly constituted Karachi Joint Water Board, with a Chairman. According Mr. Malik, the present Chairman, the future requirements of Karachi city are tabulated as follows:—

TABLE XLV

Estimated Population and Consumption of Water

Year	Estimated prospective population with 30% decennial increase	Estimated daily consumption at 30 gallons per head per day in galls.	Estimated consumption for Port Turst, Railway, Military and Industrial use with 25% decennial increase in galls.	Estimated daily total consumption.
1941	3,58,000	10,740,000	1,360,000	12,100,000
1951	4,65,000	13,950,000	1,700,000	15,650,000
1961	6,04,000	18,120,000	2,125,000	20,245,000
1971	7,85,000	23,550,000	2,650,000	26,300,000
1981	10,20,000	30,600,000	3,300,000	33,900,000
1991	13,26,000	39,780,000	4,125,000	43,905,000

As reported by the Board during 1945, Karachi was supplied with 10,500,000 gallons of water per day, both from the Dumlotte system and the Haleji Lake, as a mixture in the reservoirs at Karachi. It is clear, therefore, that less water is now drawn from the Dumlotte wells than before and it has been proposed to draw only about 5 million gallons from them in future and the remaining quantity from the lake. It must be remembered that the maximum yield from the Dumlotte system itself at one time was 10,000,000 gallons per day, before the Indus scheme was put into operation and before other additional works were carried out in the Malir valley. Under no circumstances should the Dumlotte system be neglected in this manner in future.

(b) Merits of the Indus Scheme.—In one respect the canal-and-open-lake system is preferable, because there are chances for the water to be self-purified by sunlight and ultra-violet rays falling upon the running water and by aerobic bacteria oxidising the organic matter. But there is a limit to this in the Kalri-Haleji water works, which in their present state, are rightly criticised.

(c) Demerits of the Indus System.—(1) The Haleji lake, which forms the main reservoir of water, was originally a Dhand or salt-water lake and however much it is modified, the danger of seepage, Kalar etc., is always connected with it.

Again, low levels in the vagarious Indus must mean low levels in the lake. Although its designed level is 14.3 ft., at times it lies as low as 6 ft.

(2) The Kalri Canal flows only for the season and water is bound to remain stagnant for the rest of the year. The more the water evaporates due to solar heat, the greater is the quantity of soluble salts left in it.

(3) The vegetation, growing and decaying inside the lake together with the animal life connected with it, is a constant danger of contamination, especially when matter is left in a dead or decaying condition in it.

(4) The lake is open to and within the path of the S. W. Monsoon, so that there will be a certain amount of blown-salt and blown-sand brought into it.

(5) The conduit, especially from the lake to Gharo, is laid underground and is not water-tight. There is a danger of seepage also through Kalar soil. Thus there is a large amount of temporary as well as permanent hardness in the water when it reaches the reservoir at Karachi, so much so that the water in the Kalri canal is purer than that in the lake and in the lake purer than in the reservoir.

(6) The water has to be twice lifted to a height of about 150 ft. continuously, so that there will be a constant strain on the machinery and in a province with no chances of fuel or hydro-electricity, there is bound to be a heavy recurring expenditure on this account as well as on account of the supervision and vigilance of the Board.

(7) But the greatest fear to be entertained regarding the Indus System is that it may give, and to a certain extent it has given, a set-back to the Dumlotte system. The authorities have a predilection for the Indus supply and not the Dumlotte supply, which once was the only support and had reached the limit of 10,000,000 gallons of water per day. As we have seen, for most of the monsoon season, all the water flows down to Karachi reservoirs by gravity and the rest of the year only by moderate pumping through the depths of the

wells. If after spending a crore of rupees, the Dumlotte system, which has decidedly a purer supply of water, is to be considered secondary, and the water from the Haleji lake is to be pumped throughout the year to a height of 150 feet and for a distance of more than 50 miles, one wonders whether the change is for the better or for the worse. Besides, the Kalri Canal as well as the Haleji lake have a limited capacity and will not stand the rate of increase of supply in future years, unless the lower Sind barrage is constructed.

(9) **A Review of Suggestions made.**—There is no doubt the water supply of Karachi is not yet what is desirable from the points of view of quantity, quality and safety.

To improve and reassure the supply of the city, then, the following courses are open:

(1) The authorities should maintain the Dumlotte system as bests as they can and, as far as possible, to lift the water-table in the Malir valley and to prevent the surplus water from running to waste into the sea. It is still advisable to construct some terraces and low dams across the Mol and the Khadeji valley at convenient places so that heavy and excessive surface run-off may be at least partially prevented and the water-table may be raised by allowing this excess water to enter the alluvium. Deep trenches in the sand and more cross galleries would also perform a similar function. Anyhow, the excessive run-off and the underground waste of water percolation through the sand and gravel must be stopped by uptodate engineering methods.

(2) Fair chances should be given to more artesian borings, in order to draw purer and uncontaminated water at high pressure, from such depths as 1000 to 2000 feet in the Nari sandstone. Younger Tertiary rocks, such as Manchar and Gaj limetones, are objectionable as they contain connate salt water, but from the Nari rocks of fluviatile origin, there are no such disadvantages. The trial deep-bore at the Bazar-Malir juction was not carried to the depth of the Nari rocks. A few artesian borings in the Lyari valley would be productive. Deep borings in the Indus delta are also desirable.

(3) The Haleji lake should be remodelled and care should be taken to prevent seepage and the growth of injurious organic matter. The decaying vegetation must be removed from it at any cost, from time to time.

(4) The conduit from the Lake should be made water-tight throughout its length.

(5) For a number of years yet, and for a good mixture, atleast **half the quantity** of required water should be drawn from the Dumlotte system and stored in a separate reservoir, so that for **drinking purposes**, this fresher and better quality of water may be distributed for certain hours and allowed to be stored by the **educated** classes.

(6) Due to the high prices of machinery etc. the proposed lower Sind barrage near Kotri is not likely to be functioning for some time more, and therefore the Dumlotte wells and galleries must be carefully maintained. A few decades ago, such a barrage would have been constructed for less than a crore of rupees, but now it is estimated at Rs. 40 crores. This is so, because the authorities have never adopted a long-range policy in Sind.

(7) For a permanency of the Indus System and for the development of agricultural lands a barrage will have to be constructed at **Kotri alone** and not at Dapuri, Jungshahi or Jherruck, as in these localities the river is not at any fixed point and due to excessive silting etc., it is bound to change its course in future, actually bypassing the Barrage at any time. At Kotri, which is the second fixed point in the whole course of the Indus through Sind, the geological conditions are satisfactory, there being hard clay-beds resting against gently dipping Kirthar rocks. It is, however, not as good a locality as the Sukkur-Bukkur gorge, although there is a danger here also of an avulsion or cut off in the loop of the river on the upstream side (**vide**—"Floods in Sind," 1943).

(8) There is one aspect of Karachi Water supply which cannot be ignored in this age. The city supply must be protected against bombing from the air. It is, therefore, absolutely necessary to maintain both the Dumlotte and the Indus sources safely, so that in case of an air attack, the entire supply may not be cut off simultaneously. Man-holes which betray the conduit line from the air, should be camouflaged and so should the reservoirs be protected. In this respect, the open Haleji lake is bound to be more vulnerable than the Dumlotte wells and the underground galleries. This is

another reason why the latter system should not be neglected in future years.

(9) In our scheme of regional planning in Sind, any side opportunity that presents itself, while introducing new engineering works, should be taken advantage of. In the present case, it will be possible to irrigate some additional fields not only on the sides of the Reservoir Branch of the Kalri Canal but also on the sides of the conduit line whenever there is a chance to use up the excess water flowing through, e.g. during the flood season. This will help in the removal of Kalar from the soil to a certain extent in the tract, by means of a system of crop rotation.

(10) A reservoir with a capacity of 20,000,000 gallons of water has been proposed by the Joint Water Board with a view to store full two days' supply of water for ensuing a continuous supply of water to all parts of the city at one time. At present when any repairs are to be made, some parts have to be cut off, although at Mile 9, there is already a balancing reservoir with a capacity of 2,500,000 gallons, intended for such an emergency. This precaution is necessary.

(11) Local supply of good and potable water can be secured in other parts of the Karachi area only in the neighbourhood of dry stream or river beds and in their alluvium.

2. **Drainage Improvement Scheme.**—Side by side with the question of water supply, the problem of the underground drainage system has to be solved. The present system has outlived its capacity. Already Karachi has been suffering due to its low levels from floods of its surface drainage during the rainy season. The rising mains, the Shone System of ejectors, the pumping stations and machinery, all have to be overhauled, duplicated, supplemented or substituted by more modern types.

As has been already pointed out (**Vide** Part II Section E. 5) the drained area of Karachi city is about 63% of the populated area. Of this drained area, again, about 43% is lying on flat and low-lying parts of the city. The sewage from these low-lying localities, covering 2182 acres, has to be ejected and pumped up, with a pressure head of about 25 to 50 feet, to the pumping station on Barnes Street at a higher

level through a pipe length of about 13 miles. As this sewage is under such a pressure and the mains are unsuitable, old and corroded here and there, they burst, causing a good deal of insanitation and ill health in the city. At times the overflow of sewage water is due to the opening of compressors for checking and opening air valves near ejectors. Again, at the dead ends of the mains, matter stagnates for some time, and contamination of drinking water takes place in transit, in many parts of the city. The remaining drained area of 2810 acres have sewers, through which the sewage flows by gravity to the Pumping Station. All sewage is ultimately pumped up to the Sewage Farm beyond the Lyari.

To overcome these difficulties, a scheme has now been prepared by the Karachi Joint Water Board, suggesting that the number of zones, in which the ejectors are installed in the drained area, should be reduced and as many intercepting gravity sewers as possible should be replaced in the rising mains. Once the sewage is allowed to flow into chambers by gravity wherever it is possible, the load on the mains and the ejectors will be reduced in lifting it.

It has to be seen how the revised scheme works, how far the Shone System is carried out further and how the problem is solved with the existing mains **without duplicating the lines and the plants,** when we know that the population of the city has quadrupled since this system was introduced decades ago.

The question of manufacturing compost on a large scale also remains closely connected with this drainage scheme and the modern system of sanitation.

SECTION G.—PLANNING FOR THE FUTURE

1. General Principles of National Planning.—A wave of nationalism is passing over the different countries of the world and is making the peoples conscious of their own political units and the contributions they can give to others. National Planning, therefore, is a subject of vital importance and great moment to us today. In the post-war reconstruction of the world, our country must play a very prominent part on account of its infinite resources of certain kinds and its age-old civilisation. The belligerent nations have fought and exhausted their resources and their reserves more than they could produce for the last six years and more, and the economic order of the whole world has collapsed. To replace and replenish the stock of goods thus lost and to restore the balanced economy will be the pivot of all post-war planning, both national and international.

In this huge task, India with its vast potentialities must not only try to make itself self sufficient (though self-sufficient no country can boast of becoming) but it must also lead other countries in some respects. Economic planning and reconstruction are necessary at every time but as India has been fortunately away from the war theatres, it is in a position to develop its resources further region by region, even at the present moment, and accelerate its productions to meet the increased demand and consumption without delay.

But any process of reconstruction or planning of an economic or social character must be based on the geography of the land and not otherwise. Economists have to keep their feet well placed on the earth before making any vague calculations; for, Nature has so ordained that certain products will be found in certain regions and certain minerals only in certain rock formations. This uneven distribution of natural materials is made by Nature on purpose. It is to teach mankind the lesson of inter-dependence, good neighbourliness and peaceful evolution of human life by co-operative methods. Besides, the world is fast shrinking owing to the extraordinary advance it has made in the field of aviation.

(1) International Planning.—All international planning is, therefore, to be done on the basis of a World Federation, according to the different characteristics of diffrent countries

and their peoples. They must all be federated units on the principle of equality and fraternity. All distribution of natural wealth, minerals and ores, fuel and raw material, production and consumption, labour and trade and even colonial development, if any, must be controlled and regulated on the basis of law, justice and equality, so that no nation can have an upper hand over another and no people may live in want and misery, least of all, our Indian nation.

Stressing upon the necessity of scientific factors in the post-war industrial development of India, Dr. Sir S. S. Bhatnagar recently stated: "Narrow ideas of nationalism should not blind us to the facts of science or of history, for industry is a plant which seldom grows to its full height in a soil, which is not kept fertilised by ever fresh additions of scientific knowledge, which no country could either monopolise or claim as its very own for all time to come." And while locating our industries, care should also be taken that they are well distributed over the entire region on a planned basis. For, says the same authority, "Industries should be planned to be distributed over the whole of India with due consideration of such factors as raw materials, labour, power etc. The broad principle that the advantages of industrialisation should be spread over as wide a population and area as possible, should not be lost sight of."

Now India with its vast sub-continental areas, its varied rock formations and hydrography is yet pregnant with precious wealth, which has not been fully explored. They need men and women of unswerving faith and hope to unearth them and make them the property not only their own but of the whole world to enrich their life and other's life. Herein lies the hope of the New World and the New Life which is now dawning upon us at this moment. Who knows that it may fall to the lot of our Indian scientists, owing to our very civilisation, to invent a method whereby the atomic energy can be utilised not for any destruction but for construction and reconstruction all over the world.

In the modern world, people have allowed the physical sciences and their offshoot, the Machine, to run away with them. It is high time that we pay attention to the old and the new cultural sciences, to assure a peaceful, orderly and well-planned future of the world.

Again, the national self-sufficiency of every country has to be internationally planned to avoid any aggrandisement and aggression, as there is hardly any country that can be entirely self-sufficient in all respects, as stated above. As such a self-sufficiency is not attainable due to the peculiarities of the native rocks, soils, climates etc., the international mode of planning must aim at mutual aid to make up the deficiencies, by means of co-operative exchanges of materials. The U.S.S.R. offers an excellent example of what economic achievements of planned progress can be. But even this country can never be self-sufficient in every respect. Jute, for instance, is a product specially destined for our Bengal and the U. S. S. R. must depend on us for its import. It is, therefore, absolutely necessary to reconstruct the world in such a way that proper inter-national planning is done, when it is only based upon the geographical distribution of its natural wealth.

(2) **Planning In India.**—Our own country with its natural surroundings, its first-class frontiers and 5000-mile sea board is a more or less perfect geographical unit. It possesses, besides, a great store-house of mineral wealth, agricultural products as well as long-cherished traditions and varied cultures. But different physiographic regions, within this single geographical unit, again, have produced different raw materials and different cultural groups which need to be wisely co-ordinated, if we wish to give our valued share in the world's reconstruction. Hitherto a wrong policy with regard to its economic development and industrial progress has been followed and much natural wealth, including precious minerals such as mica and manganese, has been recklessly exported. No wonder India suffers from many economic hardships derived from external powers and parties and internal communal tension.

Mroeover, any kind of economic planning must have a bearing on village reconstruction and all capitalists tendencies in our country should be stopped.

The root-cause of our political troubles is the most unnatural and unsuitable political boundaries, haphazardly made, as the British took possession of the country step by step from the native rulers. Because the conquest of Sind was made by a Bombay army on its way to the Punjab and

Afghanistan, Sind remained as an unnatural and unwieldy appendage of the Bombay Presidency for well-nigh a hundred years! Much communalism, sectarianism and provincialism, again, are caused by such unnatural divisions and their subdivisions into presidencies, provinces, states, districts etc. without any homogenious background for a really national all-India plan. These undesirable boundaries must now be broken and natural physiographic boundaries should be set up in their place, so that the people may not live as separate communities but as comrades for the growth and development of their own regions, without any troubles or anxieties. Religion must be allowed to be the people's own personal assets and must not be interfered with on any account. It is true that in India we breathe the same air, eat the same food, drink the same water, cultivate the same soil and wear clothes, though different in shape and side, yet made of the same material, irrespective of our own religion, caste or race.

There is not a crop, either food or money, which India cannot produce by modern methods, if it is well looked after, if its soils are well fertilised and its rivers well trained. What is lacking at present is a thoroughly scientific survey of our resources and a proper planning of their development by our own scientists. In other words, a regional geography of the country of India, division by division, is yet to be prepared in the first instance.

Such a survey would also solve the problem of over-population. India is not really so much over-populated as its population is badly distributed. Its material wealth is thus wrongly distributed, so that while millions go half-starved or starved, many thousands grow fat at their expense. Thus food-planning will solve the problem of population-planning.

Of minerals also there is no dearth in our country. We are first in the world with our output of mica and second only to Russia with that of manganese. Our iron and coal resources are inexhaustible. But we must import mineral oil from abroad, as our Indian rocks have not yet yielded this precious substance. So, as we have said before, we cannot have self-sufficiency and cannot be quite independent of the rest of the world. In fact, no provinces in India, whether political or physiographic, can be so self-sufficient owing to this very uneven distribution of

natural wealth and resources, but they must depend upon one another.

And so India is destined to be great but only by co-operative efforts. Besides, our different cultures, formed in different physiographic regions, require to be well irrigated by a system of cultural canals cut across the man-made barriers. Without this kind of acculturation in India, there can be no national planning, as the Indian National Planning Committee has defined it already: "Planning under a democratic system may be defined as the technical co-ordination, by distinguished experts, of consumption, production, investment, trade and income distribution in accordance with social objectives, set by bodies representative of the nation. Such planning is not only to be considered from the point of view of economics and the raising of the standard of living; but must also include cultural and spiritual values and the human side of life."

(3) **Planning In Sind.**—Like every other Indian province, Sind is bound to play its part and play it well in national planning. For, Sind is an excellent natural (physiographic) sub-region of India, 'viz.' the lower Indus basin, largely consisting of the delta of the great and classic river. Without the Indus, it would have remained a part of the Rajputana desert. Sind lies in a critical corner of India and has acted as an ante-chamber and a half-way house for the whole country. It has given its very name to Sindhustan or Hindustan and to its spiritual and economic wealth too it has contributed freely in the past.

Barring the possible discovery of petroleum, Sind's mineral wealth, however, is meagre. The whole region is covered over with sedimentary rocks of the Tertiary age, the predominent deposit being limestone. Reference has already been made to the possibilities of manufacturing calcium salts e.g. soda ash, bleaching powder and calcium chloride, from them, in Part I Section F. The cement industry is already in a flourishing condition. Among other minerals must be mentioned the almost inexhaustible deposits of common salt in the Thar desert area of the Eastern Valley Section, e.g. near Allah Bund from Raoma to Wanga Bazar, and in the Indus Deltaic Area, e.g. Surganda salt deposits near the Sir Creek and those between the Gora and the Koree Creeks. We have

also abundance of gypsum for manufacturing plasters, ceramics, refractories, fillers, sulphuric acid and ammonia sulphate fertiliser; salt petre for explosives, fertilisers, glass and potassium nitrate, ochres for pigments, Fuller's earth for decolorising and filtering of fats and oils and for toilets, fire clay for refractories and glass pots and other clays for ceramics, bricks, tiles and cements.

Again, we have horns and hoofs for manure and plastics; bones for bone meal and phosphates, oils for soap, glycerine, tallow, water proofing and cakes manure, and lastly, fish for isinglass, fish oils, compound lard and manure.

But the best wealth of Sind is its land, which is most cultivable when it is best watered. This fertile drift soil derived from the denudation of the rich rocks and minerals in the far-off Himalayan mountains, has been a lodestone for a large number of foreign peoples, who have preferred to settle in this deltaic region from the days of Mohenjo Daro and to share their cultures with one another. The cultural wealth of every immigrant race has taken firm root in the Indus valley soil. Here the Arab horse and the camel, the Rajput Hari and the Makrani donkey man have contributed their wealth and welfare. Such a cradle of human civilisation can never fail to give its legitimate share in Indian national planning in years to come.

The best use of land is the utilisation of all its resources for all mankind. Let us hope that these resources are properly explored by our own scientists, plotted and mapped by our own patriots and distributed and redistributed by our own economists on co-operative lines, as the fundamentals of a Master Plan. Thus in our scheme, the physical and communal boundaries should gradually change into cultural ones. There is no physical barrier against science in this age. Therefore, there must be some mutual understanding between the peoples of different cultures and they must endeavour for the future glory of the province and its capital. Where nature has not allowed such an assimilation due to physical barriers so far, e.g. the Makhi Dhand (a salt lake), wild criminal tribes have gone on living apart and created disruption. When civilised man handles the Hur tribe carefully and sympathetically, the unification will be complete. The oases of cultures in a vast but semi-arid

province must be canalised and unity must be arrived at. Unity within the diversity. True culture, in other words, must transcend the physical and external peculiarities and seek the internal unity. Thus regionalism must be grafted on the physiography of the land and man be helped to win victory over nature.

2. Planning of Sind's Capital: Karachi.—Karachi, the capital of modern Sind, is getting ready for this gigantic task of planning. But we must know Karachi's natural wealth, resources and natural potentialities. It has already had a century of progress with its semi-natural harbour and its vast habitable space and extensive area. Its population has had a most extraordinary growth in recent decades but its future is to be assured. Karachi lies vigilant on the Arabian Sea coast, with its harbour-mouth wide open like that of a huge python lying in the lower Indus valley, which, in its turn, is watered by the artery of the river and fed by the sinews of the Barrage lands. It is bound to take in and assimilate all that is offered to it in future years and to grow materially as well as spiritually.

(1) Four Stages of Karachi's Growth.—Before making any plans, let us remember that Karachi has already passed through a number of stages in its growth and evolution and that the influences of the time factor and the man factor upon this place have been well-marked.

1st Stage.—A fishing village with the material environment of the sea and without any contact with the interior or the outer world. There was only uncivilised life on this account.

2nd Stage.—A native port. Seth Naomal and other patriotic Sindhis tried to utilise the Bunder as it was and as nature left it in their hands (pre-British period).

3rd Stage.—Karachi becomes the capital city of Sind after the British conquest in 1843. The partly natural harbour becomes artificially improved and trade and commerce are highly stimulated. The city limits extend and a municipal commission is also established. It is decidedly a transit city.

4th Stage.—This is the present improved stage. Karachi is not merely a transit place but also a gradually industrialised

city. It is not merely a first-class sea port, but also an excellent air port and a railway terminus. It at once becomes a cauldron of various cultures. Peoples not only from harsher climates and less fertile regions but also from more favoured parts now enter here. **(See Plate III B.)**

And a 5th stage can be envisaged for it as the Sindhian Riviera of great future for Sind and the Air Capital of India.

(2) Regionalism vs. Communalism—Geographical patterns must have much to do with cultures and they must be followed in our scheme of national planning in Karachi. There should be no violation of nature's laws in this respect. These geographical patterns influence the people's life in the city and their heritage must be based on the background of geography. In other words, there should be an unification of the cultures of the various communities living in Karachi, (apart from their religions) not in spite of their diversity but because of it. Great qualities and virtues must transcend sectarianism and physical obstacles and bind the province with its capital city as the nucleus.

This haven of Karachi has already played a constructive part in Sind and this process must continue in the planning for the future, inspite of the rivalry of the communities for power and possession. Indeed, in the tremendous task of the planning of Karachi, the disturbing elements of baseless economics and politics should not come.

(3) A Long-Range Policy.—There must be in our scheme of planning a long-range policy of regional consideration of every one of our problems. In other words, no plan or scheme should be taken up haphazardly and singly without a regional and co-operative outlook. For instance, even the problem of water supply of Karachi has to be connected with the construction of a barrage for Lower Sind at Kotri and the cutting of the Karachi Canal through the intervening hills, which by the way, are also to be blasted for a geophysical prospecting for mineral oil in them. Similarly, the development of the spa at Mangho Pir has been delayed for want of co-ordination with a scheme of satellites for Greater Karachi. This is not possible unless there is a single administrative authority of the whole area or at least a hearty co-operation between the Karachi Municipal Corporation, the Cantonment

Board and the Karachi District Local Board. Much harm is done to Karachi, if such an interrelatedness is not sought between all the local authorities, when a scheme is afoot.

Hitherto, Karachi has been largely a city of loading and unloading and a portion of its rapidly growing population must be a floating one for this reason. This must make it possible for Karachi to be one of the richest cities in India.

The fate of Karachi, again, is closely connected with the share it has given, due to its geographical situation, to the establishment of the airport for trans-continental flying, so that Karachi's claims for grants from the Local and the Central Government, for some of its future schemes, can never be discarded. Had it not been for the exigencies of the War, the question of the Indus scheme of Karachi's water supply would not have received that attention from the Government, which it did receive in 1942. In short, the problems of Karachi will be the problems of the rest of Sind and even of India to a certain extent. They will not have a local importance only. They shall have to be considered regionally and by a long-range policy and on co-operative basis. The Sind-Punjab water dispute has now become a scandal because of such a policy of isolation, and the solution is inordinately delayed. Only powerful organisations of the type of TVA can overcome such obstacles in future in large-scale operations.

(4) Why Karachi Must Plan.—Like all other cities Karachi must have some kind of planning before it is too late. Already it has reached a stage when an expensive Improvement Trust under the Town Planning Act will have to be instituted to make alignments of many old roads and cross roads and their corners, to remove congestion in the Old Town and neighbouring areas, to provide for well-planned houses for the poor labour class, to remove the obstacles of warehouses and godowns in the heart of the city, to relieve the Bunder Road of some of the load of traffic, to look to the drainage difficulties, to protect the city against fire, earthquake, seaquake, disease, war, etc. "A proper city-plan" says George McAneny "has a prowerful influence for good upon the mental and moral development of the people, and is the firm base for the building of a healthy and happy community." Again, "its province is not confined to the solution of

abstract problems in engineering, mechanics or finance. It deals with a living, moving organism, comprising the thousands of human units, who by force of social demands, industrial needs or the operation of economic laws, group themselves together in great communities." Thus, it is not for any spectacular purposes or the building of roads, parks, squares, boulevards, race courses etc., but for meeting the real needs of a living city, inhabited by a dozen peoples of different religions, customs, manners and ideals, that we have to do planning in Karachi. Once a mistake is made, as it has been in allowing it to have "a mushroom growth" for the past few decades, once people are allowed to inhabit an area and to thrive within it, it is difficult for any Government to correct it. We do not want a city of dust and smoke and filth, but a city of love and labour and light. We want it to be so, because, as says Radha Kamal Mukerjee, we want to achieve "the integration of life's activities and the expression of creative impulses. Thus beauty may once more be restored to our towns not as ornamentation confined only to temples, tanks and gardens, but as one coherent vision that lives through all parts."

(5) Planning Of Greater Karachi.—Again, in the planning of Greater Karachi, we have to take lessons from the past, from the ruins of ancient cities such as Mohenjo Daro and Chanhu Daro and continue their traditions, which Sind has received as a heritage from our ancestors, instead of blindly imitating the plans of foreign cities and foreign aspirations. In a province of shifting sands and changing hydrography, Karachi is singularly devoid of any great temples, mosques and other religious monuments, in which other Indian cities generally abound. But we must have in Karachi at least some substitutes of these in the form of great cultural centres, seminars, museums, studios, special schools, swimming baths, stadiums etc., which can be thrown open to the believers in all religions and prophets, without any caste restrictions.

Vast lands within the limits of the Municipal Corporation are yet to be developed and occupied by the peoples. More amenities of life, more food, more houses, and more lines of communication will have to be provided for in the near future. We have seen that the population of Karachi has

been increasing at the rate of 5,000 to 10,000 per year, but our food resources have not been proportionately improved and our water problem has not yet been satisfactorily solved for all times.

(6) Problem Of Industrialisation.—In a province, in which urbanisation is always at a discount, the one and only city worth the name, must have some rural patches here and there to remind the inhabitants that Sind's main and stable industry is agriculture and however long they wish to stay in Karachi for any business, they must be true Haris in spirit, if not in name. Thus the future planning of Greater Karachi will have to take account of a regional planning in the whole of Sind.

Luckily for Karachi's planning, its industrialisation is yet in the making and this will take due account of the sites for residential and labour colonies to go side by side with the new factories and workshops outside the habitable areas. Let us convert this comparatively modern city into an up-to-date industrial city as well, by removing congestion and insanitation from the City limits, wherever they are found, and by relieving our main thoroughfares from some of the fast-increasing traffic and our habitable and cultural quarters from the nuisance of smoke and noise. In a dry region like this, the green belts will only be restricted to the two river valleys, but belts of open country can be provided between some Satellite towns, which, in their turn, will need proper layouts and improvements of the existing townships. All this will involve a fresh programme of roads and suburban railways, as the internal structural conditions will not permit of an underground railway in the heart of the city. In this way, it will be possible to employ a large number of demobilised men and women in the execution of all our schemes for a healthier, greater and more rational Karachi, provided they are given a regional bearing, with an element of **tradition in the planning.**

A number of traditions is already found in the city establishments. The pretty old but sound Dumlotte system of water supply, the noble tradition of the original fishing village, the traditions of trade and commerce inherited from pre-British times, the limestone buildings and other traditions, however young, are all there and can be continued with advan-

tage. The aim should be to reconcile the old with the new requirements and to make progress by harmonising their expressions.

Lastly, if India is really over-populated, Sind and Karachi are certainly not. There is yet a tremendous scope for colonisation in our province everywhere, the density on the whole being as low as 94. Thus the solution of India's national planning will be reduced to planning of inter-provincial immigration, which will, in its turn, resolve itself into population planning and economic planning.

(7) War-time Defences.—Karachi is singularly lucky in the original island structure of its coastline and extensive sandy beaches for establishing ideal marine air ports with the additional advantage of the prevailing wind direction in the creeks. At Korangi Creek, one has already been established apart from the old one at West Wharfs, owing to the exigency of the War. If it turns very stormy during the monsoon season, another suitable one can be made at Baba Island to take its place. The geological make-up of the interior of Karachi has enabled the authorities to build aerodromes at Maurypur and Drigh Road over vastly denuded flat hill-tops and aggraded valleys, covered with heavy calcareous sandy soil, so that long and durable runways, draining quickly after rains, can be provided all the year round.

To prevent any unauthorised landings on the beaches, an effective use can be made of the numerous cliffs along the sea shore and defence provided against any invasion.

Again, there are chances of providing several good camping grounds with **local** water supply in Karachi's neighbourhood near the green belts, which can be further developed by means of tube-well irrigation.

3. **University Of Sind**—But all this cannot be accomplished without establishing a powerful University centre for the whole of Sind. A University of Sind, in its real sense, is a University of culture. It must have among others two most important Faculties, the Faculties of Agricuture and of Sindhian Culture, attached to it.

(1) Special Faculties.—History repeats itself. And just as Sind was a lodestone for many long centuries and for

many classes of mankind, having been attracted to it by its river and its soil, so should the new University of Sind be a lodestone for those who hunger and thirst after a unification of India's cultures. The Indus river has, indeed, played a precious part in this process of unification and creation of the Sindhian culture and Sufi culture. It has united not only Sind itself but Sind with Hind ever since the days of Mohenjo Daro. The rich product of Sufism, a real and healthy combination of Hindu culture and Islamic culture, can be the panacea for many ills, from which the province is unfortunately suffering today. This can only be done by means of a thoughtful programme of acculturation in this Faculty.

So also for the study and research of Sind's rich alluvial soils, for the solution of the problems of irrigation, canal construction, barrage making, hydraulic data finding, seepage, water logging and Kalar soils, the University of Sind in its Faculty of Agriculture must attract students from all other parts of India and abroad.

Hydrography and hydrology will have special fields in Sind and with the growth of the air services aeronautics will also be a speciality of Sind.

A powerful research department will have to be established in this new University. We shall not accept the University to be a mere examining body. It will have to be a unitarian and residential research University to act as the beacon light for this side of India. It is long overdue.

(2) **Karachi as the University Centre.**—Incidentally this new University will be the University of Karachi, as its nerve centre can be Karachi and no other place in Sind. Feeding the whole Indus valley and facing the vast Indian Ocean, Karachi, the hope of the entire hinterland of Sind and the Punjab, has come to stay, unlike those old cities of Sind which are obliterated from the face of Sind due to the vagaries of the very river, which gave it its birth and its life. But Karachi must have such a cultural centre as would dissolve communalism and generate regionalism of a constructive character as shown above.

A united India needs a united nation. So does a united Sind need a united national life, both material and spiritual.

Here in Sind, spirit can conquer matter more easily than anywhere else in the country. Sind can march faster towards India's unity due to its hardships, its natural unity as well as its linguistic and racial unity. In short, with a University having only high ideals of service and of culture, it will be possible to nationalise education in Sind, in order to help nature in the slow but sure process of unification.

4. **Other Tangible Plans For Karachi.**—A few more suggestions for the actual planning of Greater Karachi are made below:

(1) The Satellite Scheme.—For a city like Karachi, which is now in the adolescent state, the Satellite Scheme already proposed (**vide** Pithawalla: "Problems of Greater Karachi—a Scheme of Satellites," Karachi 1939) is the most suitable. The centripetal tendency for people to flock into it from many quarters, even temporarily for business and trade, is too strong at present; we must try to suburbanise more and more areas around Karachi and thus help the population to be centrifugal as well. By instituting a system of daughter towns around the parent city, **all under one cultural authority,** we shall satisfactorily carry out the principles of the Abercrombe Plan.

Already a number of suburbs exists **(See Section E. 9 (6): Suburbs)** and they can be easily remodelled on the following lines:—

	Satellite	Utility
(a)	Clifton	A seaside resort, a Riviera.
(b)	Ghizri	A colony, sister to Clifton and a sanatorium.
(c)	Drigh Road-New Malir	An Air Port and a Cantonment station.
(d)	Malir	A garden colony and a University town.
(e)	Landhi	A sister to Malir and a University town.
(f)	Mangho Pir	A spa.
(g)	Mauripur	A factory town and an airport (civil).
(h)	Manora	A fort and military depot.
(i)	Korangi Creek	A seaplane port and a fish-curing and canning centre.
(j)	Dalmianagar	An industrial town with its labour colony attached to it.

These small towns, revolving round the central city, will relieve it from much congestion, insanitation, industrial smokes and noises, dangers from air raids, and, above all, ugliness which generally accompanies old city growths. They can have their own separate systems of water supply as well. The position of an Industrial Town on the N. E. quadrant of the city will save it from the smoke nuisance. **(See Plate I)**

There are other benefits to be derived from this scheme. The country side, poor as it is in the neighbourhood, will be preserved and any natural beauty, that may be there, will be maintained. The rural community, which is the backbone of Sind, will also be catered for. The gardens of Malir and Landhi will be utility gardens for regular food supplies, including milk and its products, and will prove to be a good training ground for the Faculty of Agriculture in the University. Karachi frequently suffers from a dearth of vegetables and fruits, because the Sindhi Hari is not accustomed to their growth. He has not yet realised the value of compost from the wastes on the countryside in this connection. This deficiency will be supplied in Karachi by a careful planning of the Satellites, on these lines.

Each villa or cottage in the colonies will produce its own vegetables and fruits. The fields in the intervening belts will be required for all future developments. A labour colony attached to the factories in the satellite of Dalmianagar will eliminate the necessity of transporting labourers daily from and to the city, except those who will be needed for the harbour works and who can all be lodged at Keamari.

Lastly, with a single Municipality to control the city and its satellites, Greater Karachi will be a pride of Sind, without the blunders made of allowing cities like Bombay to grow independently of its suburbs under separate Municipalities, with advantages to none of them. In short, a kind of regional and not patchwork planning is all that is required.

No restrictions as to building constructions in the city itself or to colonisation in future will then be necessary. The city will then rival with other great Indian cities. Even with no long history behind it, the port of Karachi, owing to its vast and fertile hinterland, is in a position to do great things in the future, if it is properly linked up with its satellites.

(2) Construction of a Circular Road.—For such a satellitium, a system of rapid transit facilities is required.

The first step to be taken in this direction is a Circular Road for the city. Today it does not boast of any radial system of roads or even a system of thoroughfares keeping pace with the traffic, although the singular Bunder Road and its Extension have admitted quite a ribbon-like growth.

In constructing a road, going round the extreme ends of the city, it is possible to utilise some of the existing roads with proper alignments and extensions and some Kutcha roads with necessary adjustments.

Starting from the Port Trust Office and taking the Harris Embankment and Pilgrim Roads, at first alongside the Lyari left bank, we cover a large quadrant on the western parts of the city. Near the junction of the Haji Camp Road and the Barnes Street, a straight cut can be provided for this road to join with the Lawrence Road. Turning to the right in continuation of Martin Road and utilising and improving a small portion of the Kutcha road behind the Jail, we arrive at the Sehvan-Malir thoroughfare. Crossing it over to another Kutcha road, at present made in the valley between the Mutrani Hill and Hand's Hill, we swing round to the left and come to the N.W.R. Carriage Workshop. Another road, parallel to the railway lines, will lead to the Cantonment Station. It will be, then, easy to go along the Kutchery and McLeod Roads, or the New Queen's Road, ultimately to return to the Port Trust Office.

Altogether the distance covered is from 15 to 20 miles, of which more than one half already exists.

There are really great advantages, if such a ring road around the existing city, with provision for its future extensions, is constructed. It will offer direct communication between some of the existing important roads, between two or three arterial roads, and reduce congestion on them. It will safeguard the city from all its sides, in times of peace as well as danger. (See **Plate I**)

(3) Development of a Semi-Hill Station for Karachi.—But the greatest advantage of this Circular Road is the possible development of the Hand's Hill into a semi-hill station, within

three miles of the outskirt of the city and under the influence of the sea breeze and the monsoon winds. It is 223 feet high above the sea level. One very discomforting feature of the whole of Sind is that there are no hill-stations available. The only chance for us to have a Cumbala Hill for Karachi is this Hand's Hill, which is at present only quarried for building stone and road metal and on which there are some huts for quarrymen. The new Service and High Pressure Reservoir is within a short distance from this Hill and, if a pipe line is laid, it will convert this hilly area into a hill garden, rarely to be found in other parts of the Karachi district.

A railway station intermediate between the Cantonment Station and Drigh Road, somewhere near the Shuttle Train Yard, will add to the utility of the area under development.

(4) Recovery of the Cantonment Areas.—For the proper development of Karachi it will be necessary to remove the few remaining Cantonment areas from the city limits and shift them to Drigh Road and New Malir. At present there are 3 detached island-like Cantonment areas including the Napier and the Balooch Barracks. They have no separate system of water supply or even drainage and it is hard to maintain the high standard of sanitation, for which the Cantonment authorities are well known. In fact, at this stage of Karachi's evolution, Drigh Road should be entirely converted into a Cantonment, including the R.A.F. Station, to the infinite advantage of both the Municipality and the Military authorities. Administration would be more effective thereby and since more lines of communication, more local railway trains, buses and tram lines will be provided, the growth of the city as well as the Cantonment will be rapid and unhampered.

The lands, thus secured from the Cantonment authorities at whatever cost, can be of immense value to the Municipality. More parks and recreation grounds, more open spaces and public and private buildings can be provided and there would be no need of developing certain uninhabitable parts of the city into habitable quarters. **(See Plate I)**

(5) Improvement of Old Town Quarter.—Sooner or later, an Improvement Trust will have to be appointed to carry out a rigorous policy of opening out the congested parts of the town. One of the most important schemes should be to cut

up a couple of wide thoroughfares, (1) from north to south, from Merewether Clock Tower to the Corner of Embankment Road and Napier Road and (2) at right angles to it, from the corner of Napier Road and Bunder Road to the Custom House. These roads will easily reduce the load on the Bunder Road and will provide wide avenues and valuable frontages to new buildings, which may be built along them in place of the old ones that would be pulled down, as a compensation.

(6) Art and Architecture.—As Karachi is quite a new city in an age-old province, a combination of the old and the new in the architecture of buildings would be desirable. Towers and domes, pillars and arches, hanging balconies and rectangular courtyards should be prominent as an orderly development, and not a hybrid mixture of chawls and flats and markets and single-room tenements and slums for a city of floating population, but for married persons and families. Hindu art and Muslim art should harmonise the expressions, if we are really to encourage cosmopolitanism and a real blending of the two cultures.

(a) Blending of Natural Influences on Karachi Architecture—From mud to stone and from stone to cement it is a slow but desirable progress. It would be in the fitness of things, if a suitable combination of mud, stone and cement, not an ugly mixture, is produced for all future constructions, so that the geological, geographical and climatic influences on our archiecture can be happily harmonised. **(See Plate XV).**

(b) Precautions to be taken while constructing Buildings. As an earthquake means vibrations of the rocks of the earth, it is advisable to have a rigidity of structures, in all building constructions in Karachi lying within the danger zone, to enable them to vibrate with the ground. They should also be provided with elastic columns to enable them to oscillate about an inch or two, without any internal stresses.

These conditions are generally well fulfilled, if the structures are made of reinforced cement concrete. It was amazingly found in the case of the Quetta earthquake of 1935, that in the same street, new concrete buildings stood safe, while the old-type stone-and-brick and other buildings collapsed entirely.

Other precautions should be: 1. The sites for townplanning in seismic zones to be avoided. 2. Sites not to be located just between a river valley and a hilly range 3. Hard rocky sites to be preferred to soft alluvial sites. 4. All cables and water mains to be underground. 5. The level of underground water not to be too near the surface. 6. All thoroughfares to be wide. 7. Buildings to be rectangular with their orientation or alignment parallel to and in the prevailing direction of the shocks i.e. in the case of Karachi, to be N.-S. Fortunately this kind of alignment suits Karachi, as the predominent wind direction for the greater part of the year also is westerly and the sea breeze blows from the south-west. Buildings, lying across the path of the earthquake and at right angles to it, are bound to be seriously affected. 8. High and solid protecting walls to be provided along the coast line against any incoming tidal wave. Karachi is not lucky in this respect, as the level near Old Town also is hardly 6 feet.

(7) **Bridges, Boulevards and Baths**—Road bridges across the Lyari and the Malir are other great necessities. In times of danger, there are no escape-routes for the city. The roads to Mauripur and Mangho Pir and to Landhi and Hyderabad are usually cut off during the flood season.

It is surprising that in a sea-side settlement there are but few public baths and swimming pools. They can be provided along a boulevard at Clifton.

(8) **A Sindhian Riviera.**—There are prospects of establishing a sea-side resort and beach or marine drives all along the Clifton-Keamari facing. Of course the sand nuisance will have to be averted by providing rigid but permeable barriers or arranging for another site for dumping the dredgings from the harbour, the chief source of sand being the dredging, which is incessantly carried out to keep the harbour channel free and deep.

This improvement of a promenade is worth aiming at, as on this side of Suez there is no other sea-side resort bathed in sunshine and with a congenial climate to rival with Karachi. Such a Sindhian Riviera is bound to attract tourists and travellers from cold and cloudy Europe and now that it is the chief airport of the British Commonwealth in Asia, it is bound to flourish in this manner. It will be an

additional source of income for the Karachi Municipality as well.

(9) Museums and Aquariums.—Although the Victoria Museum is now 95 years old, it lacks a provincial character. Karachi should have a **representative** museum of all pre-historic Sindhi art. The majority of the relics from Mohenjo-Daro and other ancient cities should be found in such a museum. A sea-coast with such a rare home for marine fishery should also have a suitable aquarium on the seaside. A central library worthy of a city like Karachi is yet in the making.

(10) Water Works and Drainage Plans—Enough has been written in the body of the book regarding the improvement of the water supply and its concomitant need of drainage. Karachi will certainly require, in the near future, more sewage mains, greater facilities for preparing compost from Municipal refuse, slaughterhouse waste etc., for agricultural purposes.

(11) Karachi a Trans-continental Terminus.— Already this place has risen to be the first Air Port of India. Soon the development of railways in the Middle East should make it the terminus of a railway proceeding from Quetta to beyond Zahidan (Duzdab) and across Iran and Asia Minor to Europe. A direct Karachi-Quetta (450 miles) railway through the Las Bela State Malir-Mangho Pir-Uthal-Mangia-Bela-Pir Muhammad-Khurdar-Kalat-Quetta) would be a boon in that case. It will have several advantages over the usual Quetta route viz. quicker service for passenger and military movements, defensive safeguard on the N. W. frontier and avoidance of the weak Rohri bridge for heavy traffic.

The proposed Bombay-Sind railway must give Karachi an added impetus to trade and transport across the desert. It is a desideratum, devoutly to be wished for in these days. If Cutch can also be roped in in the Scheme, it would be better.

Within the city itself all transport services can be municipalised with profit. With the growth of communications outside the city, these services must be improved.

SUMMARY AND CONCLUSION

Where a British ship could safely anchor, the Keamari harmour was built on an island a hundred years ago and Karachi was born as the capital city of Sind.

A visitor to Karachi, arriving by air from the seaside and flying at a low height, must first discern, on his extreme right, the unusually low and irregular coastline, forming the ever growing delta of the old but powerful Indus river. Flying towards the south-east corner of the city he would discover the small gulfs and shallow mangrove swamps with the dry and sandy river bed of the Malir. Only a few flat-topped hills, which once were sea-girt islands, are noticeable towards the right, while towards the left and near the mouth of the smaller river Lyari, the visitor could find one of the busiest of Indian ports on this side of India, the Keamari harbour, protected towards the west by the Manora rock and forming an elongated N.E.-S.W. water-channel. That congested heart of the city, the Old Town, now looks like a tiny spot amidst the vast expanse of the more modern and well-planned new Quarters with parallel roads, especially the Sadar Bazar, the Civil Lines and the Cantonment. Further towards the north-east. a few arterial roads, especially the 10-mile long Bunder Road and its Extension, are running. Still further northwards, where he continues his flight, he would find a ribbon-like growth of the numerous colonies on the left side and barren rocky outcrops on the right. Quite in the heart of the city, a few island-like and open barracks in the Cantonment areas appear as an anomaly in a modern Indian city growth, while no large green belt, worth the name, is discernible during the whole course of the flight.

Karachi is the only city in Sind, except perhaps Hyderabad, the old Capital of Sind. It has risen from a mere fishing village and proved its worthiness and greatness in the province, within a century, owing to the development of its harbour, its sea-plane port, its air port and the numerous colonies that have sprung up mushroom-like in recent years. It has an excellent geographical situation, an interesting geological structure and history, a good, equable climate and an extensive, rich and well-populated hinterland. Two shallow and dry river valleys and nearly half a dozen land masses, which once were islands but are now joined with the

main coastline, have helped the builders of Karachi to secure the wide city, which it is today. There are possibilities for Greater Karachi to thrive in the near future, if certain difficulties, especially those of its water supply and drainage, are properly solved.

A kind of positive or directive planning will be beneficial to all its inhabitants, old and new. In the townplanning scheme of every great city, the factor of **social geography** cannot be ignored. Geographical factors underlie all such developments, and it is from this stand-point that the future generations may value the plans suggested in this monograph for a better, healthier and more economic life in the city and its Satellites. The city will, then, rival with other great cities in the world.

A direct shipping line from Karachi to England and other European and American countries, a direct railway to Quetta, Ahmedabad and Bombay and a direct air service to some other important cities in S. E. Asia, are among the most urgent criteria of Karachi's growth. Health statistics are good on the whole, but the Dumlotte system of water supply must not be neglected and the drainage system must improve. Protection must somehow be secured against air-borne, dust-borne and water-borne diseases.

Import and export trades can be stimulated still further and there is a considerable scope for increasing the revenue of the Municipal Corporation by revising the Terminal Tax Schedule, developing fisheries, encouraging as many basic industries, small or big, as possible and improving the lines of communication between the city and the suburbs. A trunk road from Karachi for the whole of Sind with a special road bridge across the Malir, is a long-cherished desideratum in these days of automobiles.

The growth of Karachi has been shown as the result of Sind's importance in food as well as money crops and as a powerful force in Indian national planning. The Lloyd Barrage and other prospective barrages across the Indus, not only in Sind but also in the Punjab, as a result of long-range regional planning, are bound to raise the status of the province, as a granary of Middle Asia. If Karachi shrinks and falls, Sind and the hinterland must fall. We do not

want it as a mere skeleton city in the midst of the two neighbouring deserts. If it becomes congested or unwieldy in size or if it continues to have a lop-sided growth without sufficient and pure drinking water as at present, it will do no credit to its wise and foresighted founders and caretakers for over a century now. We must learn from the example of a city like Bombay, which has suffered for want of a regional planning and has outgrown its capacity. We must have room in Greater Karachi to move about freely, to acquire health and comfort, to organise trades and industries, to establish national educational institutions and, above all, to provide for areas for recreation playgrounds, swimming pools, lidos and the most important cultural centres of a universal and non-sectarian character. We must have all the amenities of an ideal city life of joyful and healthy activities amidst well laid-out suburbs, with proper provision for labour colonies attached to the factories and workshops and with sufficient lines of communications. A solution of the appalling infantile mortality in the city is an improvement of the milk supply, which, in its turn, rests on the provision and maintenance of farms and grazing sites in the green belts by means of tube-well irrigation in these areas and the abolition of the pernicious system of middle-men and intermediate agencies. If rice can be grown by U.S.S.R. and U.S.A. on dry lands, it will not be impossible for Karachi to grow some corn in some of its suburbs. In fact, a **planned** use of water for skilful irrigation is what we want badly all over Sind.

Whatever we do for the development of Karachi and its proposed Satellites will, therefore, be for the development of Sind, for all our plans will have **a regional bearing.** While Sind's heart has been set a-throbbing with greater and more regular beats after the Sukkur Barrage, its natural outlet of excess of raw materials and inlet of the world's commercial wealth, through the Keamari harbour and the airports, must be safe-guarded and stimulated with new hopes, so that the whole system of human life within the city may be in tune with nature, whatever be the castes and creeds of the inhabitants.

In short, the future of every line of expansion, alteration or addition in Karachi is connected with the future of Greater Karachi and the future of Greater Karachi, in its

turn, is bound up with the future of the provinces of Sind and the Punjab and even Baluchistan and Makran. It will largely depend upon its supply of good and sufficient water, its motorable roads, and suburban railways, its growth of agricultural products and industries, its University ideals and upon the attitude, which the Municipal Corporation, the Cantonment Authorities, the District Local Board, the Port Trust, the N. W. Railway authorities and the Provincial and Central Governments will adopt in future towards the city. In the end, the international policy of the sea-borne and air-borne trade will finally decide the fate of Karachi, on which so many of Sind's future hopes are built.

* * *

In conclusion, let us not forget that in spite of the city's extraordinary growth and rapid advancement, we have yet to do a good deal of planning, with a view to get rid of bad housing and bad health, evil consequences of our unstable and impure water supply and imperfect drainage system, malnutrition due to lack of vegetables and pure and sufficient milk supply, high infantile mortality, illiteracy and unemployment, fears of wartime calamities and natural catastrophes, etc. There is no doubt that Karachi lacks in social and cultural planning as well, while we have yet to raise the standard of living among the poorer classes of people, by co-operative and corporate methods.

* * *

The geographical analysis given in the present monograph has showed us that some forces, far greater than we can imagine, have been at work within the Karachi area and that there is some divine purpose for which the different communities have come together to settle in the City.

If the growth and evolution of Karachi itself depend upon the inter-relatedness of the human activities with the natural environs and the forces found in the region with all the oscillations of their benefits and drawbacks, the evolution of the resultant human entities must also depend upon a wise and far-sighted programme of acculturation, without which a modern city, however big, has no right to exist, but must go under.

Will our City Fathers undertake to carry out such a well-planned policy, so that the "personality" of Karachi, may easily emerge from it and stimulate the rest of the province?

BIBLIOGRAPHY

In chronological order of publication

I. Early Literature.

1797 W. Vincent: "Voyage of Nearchus from the Indus to the Euphrates."

The earliest work in English on the Commerce and Navigation of the ancients. Nearchus may or may not have touched Keamari harbour actually.

1830 Charles Mason (Lewis James): "Notes on Karychee" Ed. N. M. Billimoria, in J.S.H.S. Vol. IV No. 3.

Gives a plan and picture of the Manora Fort and a list of other neighbouring ports, then existing.

1843 Capt. S. V. W. Hart: "Karachi."

A report on the trade and resources of the place.

Capt. T. Postan: "Personal Observations on Sind."

The Mss. is lying in the India Office Library. One of the first itineraries in Sind, recorded at the time of the conquest of Sind.

1844 Capt. E. Thornton: "A Gazetteer of the Countries Adjacent to India on the North-West, including Sinde."

A compilation of useful information gathered in the early days of the British rule.

1854 Charles Lane: "Karachi Town and the Province."

A good guide-book.

1855 Thomas R. Hughes: "The Bay, Harbour, Town and Trade of Kurachee."

Some pertinent selections on Karachi from the Records of the Bombay Government. New Series Vol. XVII Part I.

J. E. Stocks: "Plants of Sind."

Selections of the Records of the Bombay Government, New Series, XVII Part II.

1860 A. F. Bellasis: "An Account of Karachi Municipality."

Deals with some of the earliest problems facing the Municipal Commission of those days.

1867 J. W. Barnes: "Subterranean Supply of Water (Karachi)," Bombay P.W.D. Journal Roy. Geog. Soc.

1868 W. Parkes: "Memoir of Karachi Harbour."

A good decription of the natural conditions prevailing before the harbour was developed.

1873 W. H. Price: "Harbour Works Karachi."

Gives an idea of the engineering works carried out by the Government at the time.

1876 A. W. Hughes: "A Gazetteer of the Province of Sind."

The first standard publication on the historical and geographical features prevailing in Sind.

1881 Beacon Directory: "Karachi and Manora."

Goes further in the development-programme of the harbour.

James A. Murray: "Plants and Drugs of Sind."

A pioneer work on the flora of Karachi and Sind.

1890 A. F. Baillie: "Karachi Past, Present and Future."

A volume containing valuable suggestions on the future of the city, made with considerable forethought.

II. Recent Publications

1907 E. H. Aitkin: "Gazetteer of the Province of Sind."

A recent edition of the old Gazetteer and full of information on Karachi and Sind.

1915 Sir H. Evan M. James: "Memoirs of Seth Naomal Hotchand C.S.I. (1804 to 1878)."

Written by Seth Naomal himself, translated by his grandson Rao Bahadur Alumal Trikamdas Bhojwani and edited with an Introduction.

A bible of Karachi's history, brought to light by the kindness of the Commissioner in Sind, Sir H. Evan M. James (1891-1899).

1916 Sir M. de P. Webb: "Karachi and its Future."

A chapter in the **Daily Gazette** Directory for the year. a very hopeful picture of Karachi from the pen of an English scholar.

1917 Measham Lea: "Report on the Karachi Water Works."

The first substantial report of the scheme of augumenting the supply of water from Dumlotte with a diagram showing depths of water in Malir and Dumlotte wells.

"Sketch History of the Port of Karachi."

A succint account of the various harbour works carried out by the Port Trust.

1919 J. N. Smyth: "Gazetteer of the Province of Sind." B Vol. I Karachi District.

The material was originally collected by Mr. Aitkin. It gives a comprehensive idea of the population, agricultural, economic, sanitary and other conditions of the district with a few notes on places of interest in Karachi and its neighbourhood and some valuable statistical tables.

1922 W. C. Dooris: "Report on Boring Observations."

1924 Jethmal Parsram Gulraj: "Sind and its Sufis" (Theosophical Publishing House").

An excellent introduction to a great theme.

1925 Jamshed N. R. Mehta: "Karachi Municipality."

Gives a scholarly account of the administration activities and the future of Karachi and is full of foresight.

1930 N. M. Billimoria: "Bibliography of Publications on Sind and Baluchistan."

Some 872 publications of varied interests listed with an index.

1931 J. N. Sethna: "Karachi Water Works."

There are short notes on the city water supply, its history, cost of wells etc., and a plan of the locality.

1933 V. G. Shete: "Karachi Water Supply."

A priliminary note on the Indus Scheme. Alternative proposals with costs of a canal with intakes at Tatta, Quoreshi Pir, Jherruck and Kotri.

1934 Jamshed Nusserwanjee: "Problem of Water Supply for the City of Karachi."

History of the past, problems of the present, and solution for the future. The paper shows that in his opinion Karachi reached the limit of the danger zone at Dumlotte and the Indus source must be tapped.

A. E. Mirams: "Report on Improvement of Karachi."

Depicts the deplorable housing conditions of the Old Town, which he calls worse than those of Bombay.

1936 Maneck B. Pithawalla: "Historical Geography of Sind —a Preliminary Survey." Jour. Sind Hist. Soc., Vol. II Pt. 2.

1937 D. A. Howell: "Report on the Water Supply of the city of Karachi."

It considers various proposals, already made, from an engineer's point of view but not from a really scientific aspect. His opinion was that the Dumlotte system of wells when developed may yield 12,000,000 to 13,000,000 gallons of water per day, over a series of 3-4 dry years.

1938 P. R. Krishna Rao: "Squalls at Karachi."

Recording the results of some 50 squalls at Drigh Road with a velocity of about 30 miles per hour and with changes in the temperature, pressure and relative humidity.

1939 Maneck B. Pithawalla: "Problems of Greater Karachi."

A study in urban and suburban geography. Gives a short history of Karachi and advocates a scheme of Satellites. It also emphasises the need of artesian borings and other engineering works in the Malir river valley, before venturing on the costly Indus Scheme. With 3 plates and a map of Karachi and its environs.

K. R. Bhide: "Karachi Water Works."

Note No.4 on the hydrographical survey of the Malir Valley and measures essential for conservation and augmentation of the available supply.

A really scientific survey of the whole Dumlotte system and full of suggestions for preserving the surface and underground flow of water in the valley by various means.
The first deep boring was made at the junction of the Bazar and the Malir by him but unfortunately upto 800 feet only.

B. N. Mullay: "The Fauna and Flora of Sind."

A short article on the mighty subject of biology in the Golden Jubilee Book of D. J. Sind College.

1940 C. L. Mariwala: "Karachi Town, its Trade and Taxation in the First Half of the 19th Century.
Jour. Sind His. Soc. Vol. IV No. 3.

Proves that Karachi had a brisk trade, both import and Export, about the year 1837.

G. T. Wrench: "Influence of Soil on Human Character" "Healthy Soil and Healthy People With Special References to the Karachi Taluka."

Small but valuable pamphlets containing abstracts from public lectures, delivered at Karachi and showing how a sincere Englishman can benefit Sind and Sindhis. Depicts the typical Sindhi character before and after the Sukkur Barrage and emphasises the value of compost, i.e. turning the town and farm wastes through composting into humus for enriching the native soil.

K. R. Bhide: "Karachi Water Works."
Note No. 11.

A preliminary note on the supply from the Indus based on the survey and other data collected by him upto 1940. Still he thinks that the quantity of water from Dumlotte wells is purer than the raw Indus water. The Indus system to be supplementary only to the Dumlotte system.

B. N. Dey: "Karachi Water Supply and Electricity Scheme."

Recommends some deep borings by the Layne Well System upto the depths of 3,000 to 5,000 ft., as in the desert cities of North Africa.

H. T. Lambrick: "Census of India" Vol. XII: Sind contains some tables but so exhaustive as the Census Reports of previous years.

1940-41 "Administration Report of the Karachi Port Trust for 1940-41."

Gives some useful trade and other statistics.

1941 C. L. Mariwala: Origin of the Karachi Municipality."

Jour. Sind His. Soc. Vol. V No. 2.

"Thus was Karachi Municipality constituted and started functioning with many a noble errand to run."

1942 P. R. Krishna Rao and S. N. Sen: "Dust Devils at Karachi:" A discussion of some three dust devils marked at Karachi Air Port on 23-2-1941 with the aid of photographs and tephigrams.

They are strange phenomena connected with local heat and convection currents in the air over dust and sand-covered ground. They have speed limit of nearly 12 M.P.H. and attain a height of more than 3000 feet, showing clearly how unstable are the conditions of the air currents near the ground in these localities.

S. Mal, B. N. Desai and S. P. Sircar: "An Investigation into the Variation of the Lapse Rate of Temperature in the atmosphere near the ground at Drigh Road, Karachi.

In this paper are shown the arrangements made at the Karachi Air Port for obtaining continuous records of temperature in the lowest 260 ft. of the atmosphere there. diurnal, seasonal and annual variations of temperatures and lapse rates etc., associated with the development of fog.

1943 Maneck B. Pithawalla and G. S. Raisinghani: "Prospects of Fisheries and Fishing in Sind."

Jour. Ind. Geog. Jour., September 1943.

A preliminary survey of one of the most fruitful resources of Karachi and Sind.

Maneck B. Pithawalla and B. S. Rustomjee: "Contribution of the Zoroastrian Community to the growth of Karachi and its Environs." Proc. Ind. Sc. Cong., 30th Session.

Gives an idea of the pioneering characteristics of the Parsees. Also deals with the achievements of some great Parsees, Edulji Dinshaw, Sir Jehangir Kothari, Sir Kavasji Katrak and others.

1944 T. J. Bhojwani: "Municipal Post War Construction Schemes for the City of Karachi" 2nd Ed.

A report of the present conditions and the future possibilities, with details of capital costs of various schemes proposed.

J. M. Talati: "Quarterly Bulletin of Public Health for the City of Karachi."

Gives a vivid picture of the health of the city in quarterly bulletins and some hints for prevention of epidemic and other diseases.

1944-45 T. J. Bhojwani: "Corporation of the City of Karachi."

A report of the working and administration of the Municipality for the year. Contains valuable tables of statistics and graphs for the last three years.

1946 Abdul Hamid Khan: "Geographical Conditions of Arab Sind."

Unpublished Ph.D. Thesis. Gives casual references to Karachi's neighbourhood.

DESCRIPTION OF PLATES

PLATE NO.

I. Map of Greater Karachi, showing a Scheme of Satellites, etc. for Post-War Planning.
Inset: Mascall's Sketch Map of Karachi Harbour, 1774.

II. Population Map of Karachi City by Quarters. (Census of 1941.) Dot Method.

III. A. Cross Section along the Main Highway (Bunder Road), running roughly S.W.-N.E. through Karachi, showing Ground Levels and Subsoil Water Levels.

B. Stages in the Growth of Karachi City.

IV. A. Graph showing Comparative Monthly Rainfall at the Principal Indian Seaports.

B. Graphs showing Comparative Pre-Barrage and Post-Barrage Rainfall at Karachi (Manora).

V. Annual Rainfall in Kohistan and at Karachi (Manora).

Inset: Karachi (Manora) Average Monthly Rainfall.

VI. A. Annual Rainfall at Karachi (Manora) and Khadeji.

B. Growth of Population of Karachi.

VII. A. Climograph of Karachi and Madras (A Comparison).

B. Graph showing Growth of Population of Karachi.

C. Communal Composition of Karachi Population.

VIII. A. Sketch Map, showing Geographical Situation of Karachi and Lines of Communication for Imports and Exports.

B. Graphs showing Tonnage of Imports and Exports, (1939-40), Pre-War, at Karachi Harbour.

IX. A. Malir River from the Confluence to the Gorge.

B. Longitudinal Section of the same.

X. A. Wells and Conduit of Karachi Water Works (Dumlotte System).

B. Longitudinal Section of the same.

XI. A. Plan of Indus Water Supply Scheme. (Kalri Canal-Haleji Lake).

B. Longitudinal Section across the Area and along the Pipeline.

XII. Western Sind showing Ground Contours, Hot Springs, Drainage Channels, etc.
Inset: Khadeji Water-fall.

XIII. A. Aerial Map of Karachi. Harbour works in the foreground.

B. Manora Breakwaters, also showing damage done by Breakers.

XIV. Photographs Nos. 1 to 7. (Animal Life in Karachi)

1. Red Sindhi Cow—2nd calf, yielding milk 24 lbs. per day. Supplied in 1944 to Director, Imperial Dairy Research Institute, Bangalore, by Messrs. J. R. Patel & Son, Karachi.

2. Sindhi Red Stud Bull. (4 yrs.). Supplied in 1938 to Cochin State by Messrs. J. R. Patel & Son, Karachi.

3. Murrah Buffalo, Sind—2nd calf, yielding milk 28 lbs. per day. Suplied in 1938 to Government Dairy, Kirkee by Messrs. J. R. Patel & Son., Karachi.

4. White Thar Parkar Cow—3rd Calf, yielding milk 24 lbs. per day.

5. Kamori Goat. (Notice exceptionally long ears), yielding milk 3 seers per day.

6. A Sindhi Camel Cart—Used for heavy load.

7. A Donkey Cart—Note the second donkey yoked on one side.

XV. Photographs Nos. 1 to 10 (Buildings and Building Sites).

1. Adam Mosque (Bohra Musjid)—Indo-Moorish style.

2. Parsee Fire Temple (Dar-e-Meher i.e. Door of Light) —Ancient Persian architecture. Persepolis pillars.

3. Hindu Temple (Manora)—Brahmanical style.

4. Karachi Municipal Office—Combination of Indian and Saracenic architecture.

5. Hindu Gymkhana—Central India (Rajputana) style.

6. Roman Catholic Church.—A marble monument sacred to Jesus Christ in front. Gothic style.

7. Merewether Tower.—Built in honour of Col. Sir William Merewether, Comissioner-in-Sind. Foreign.

8. Kothari Parade. Clifton.—A Parsee charity. Note the building stone used, Jodhpur red sandstone. Foreign.

9. Frere Hall and Library.—Gothic style.

10. Air Mile Stone.—Showing distances from Karachi by air.

APPENDIX II

DISTANCES FROM KARACHI

1. By Land

	Miles
Agra via Marwar	785
„ via Samasata	1029
Ahmedabad via Marwar	682
Ajmer via Marwar	551
Aligarh via Samasata	986
Allahabad via Marwar-Agra	1063
Allahabad via Samasata	1298
Ambala Cant. via Lahore	942
Amritsar via Lahore	788
Bangalore via Marwar-Poona	1728
Benares	1397
Bikaner	611
Bombay via Marwar	988
„ via Samasata	1768
Cawnpore via Samasata-Delhi	1180
Dadu	218
Dehradun via Samasata	996
Delhi via Lahore	1052
„ via Samasata	907
„ via Jodhpur	781
Ferozepur Cant. via Raiwind-Khanewal	764
Fort Sandeman	914
Hardwar via Samasata-Saharanpur	948
Havelian via Lahore	990
Howrah (Calcutta) via Marwar-Agra	1575
Howrah via Samasata	1836
Hyderabad Sind	111
Jacobabad	351
Jaipur via Marwar	635
„ via Delhi	1087
Jammu via Lahore	869
Jodhpur via Luni	440
Jhansi via Delhi	1163
Jubbulpore via	1479
Jullundur Cant. via Lahore	839
Jungshahi	54
Kalka (for Simla) via Lahore	1021
Lahore	755
Larkana	282
Lucknow via Samasata-Saharanpur	1220
Ludhiana via Ferozpur	806
Luni	420
Madras via Marwar-Dadar-Poona	1868
Madras via Raichur	1774
Marwar via Luni	464
Meerut via Samasata-Delhi	949
Multan City	576
Muttra via Delhi	997
Mysore via Marwar-Dadar-Poona	1811
Nagpur via Delhi	1586
Nawabshah	182
Pathankot via Lahore	855
Peshawar Cant. via Lahore	1043
Poona via Marwar-Dadar	1099
Quetta	535
Rawalpindi via Lahore	935
Rohri	296
Samasata	504
Sehvan	192
Sialkot via Lahore	844
Simla via Lahore-Kalka	1259
Sukkur	299
Zahidan via Rohri-Quetta-Nushki	1316

2. By Sea

(1) Eastwards

	Miles
Adelaide via Fremantle	5858
Bangkok	5450
Batavia via Singapore	5280
Brisbane via Sydney	7607
Colombo	1384
Darwin via Saurabaya	6545
Fremantle via Colombo	4503
Hongkong via Singapore	6085
Melbourne via Adelaide	6357
Magellan via Valpariso	14823
Montevideo via Magellan	16213
Manila via Singapore	5990
Nagasaki via Shanghai	7400
New Orleans via Panama	16890
New York via New Orleans	17480
Penang via Rangoon	4250
Panama	15470
Rangoon via Calcutta	3516
Rio de Janeiro via Buenos Ayres	17293
Singapore via Penang	4645
Saigon via Bangkok	6090
Saurabaya via Singapore	5665
Sydney via Melbourne	6357
Shanghai via Hongkong	6930
Sanfransisco via Yokohama	12190
Valpariso via Sydney	13403
Vladivostock via Nagasaki	8050
Vancouver via Yokohama	11945
Yokohama via Hongkong	7665

(2) Westwards

	Miles
Aden	1470
Alexandria	3210
Amsterdam via London	6528
Buesnos Ayres via Liverpool	13230
Copenhagen via Edinburgh	7145
Capetown via Bombay	5105
Edinburgh via Gibralter	6735
Gibralter via Malta	5010
„ via Marseilles	5300
Hamburg via London	6750
London via Gibralter	6074
Leningrad via Copenhagen	7830
Liverpool via London	6970
Marseilles	4610
Malta via Alexandria	4030
Mombasa	4805
New York via Southampton	9035
New York via Gibralter	8210
Port Said	2880
Rio de Janeiro via Liverpool	12130
Suez	2780
Southampton via Gibralter	5895
Zanzibar via Bombay	3020

(3) Coastal Sailings

(a) Persian Gulf Coast

Pasni	192
Gwadur	263
Charbar	383
Muscat	530
Jask	661

	Miles
Bunder Abbas	795
Henjam	840
Linga	900
Dubai	979
Bahrein	1247
Bushire	1417
Koweit	1572
Kharamshah	1702
Basrah	1724
Baghdad	2224
Cuddalore	2040
Pondicherry	2054
Madras	2132
Masulipatam	2325
Cocanda	2425
Vizagapatam	2500
Bimlipatam	2517
Calingapatam	2572
Gopalpore	2643
Puri	2705
Falsepoint	2785
Calcutta	2995

(b) Cutch-Kathiawar

Cutch Mandvi	200
Port Okha	226
Dwarka	254
Porebunder	312
Bombay	566
Porebunder	247
Mangrol	290
Veraval	312
Bombay	504

(c) East and West Coasts of India

Bombay	501
Mangalore	891
Cannanore	968
Tellichery	978
Badagara	991
Calicut	1017
Cochin	1103
Alleppey	1137
Colachel	1241
Tuticorin	1342
Colombo	1492
Galle	1562
Nagapatam	1982

(3) By Air

(1) Direct Line

London	4093
Baghdad	1486
Bombay	553
Quetta	382
Delhi	691
New York	9792
San Francisco	11875
Warsaw	3083
Calcutta	1369

(2) By Stages

(a) Karachi-London

Karachi	
Basra	1134
Cairo	2113
Castel Banito	3207
Marseilles	4071
London	4724

(b) Karachi-Cairo

Karachi	
Jivani	322
Masira	679
Salalah	1082

	Miles
Riyan	1442
Aden	1761
Asamara	2207
Port Sudan	2521
Luxor	3035
Cairo	3351

(c) Karachi-Bombay-Calcutta-Colombo

Karachi	
Ahmedabad	381
Bombay	655
Nagpur	1081
Calcutta	1709
Hyderabad	1042
Madras	1370
Colombo	1790

(d) Karachi-Allahabad-Calcutta

Karachi	
Raj Samand	420
Gwalior	709
Allahabad	997
Calcutta	1354

(d) Karachi-Calcutta-Rangoon-Batavia

Karachi	
Allahabad	928
Calcutta	1275
Rangoon	1930
Bangkok	2294
Batavia	3763

(e) Karachi-Calcutta-Singapore-Sydney

Karachi	
Calcutta	1369
Rangoon	2024
Penang	2859
Singapore	3234
Soerabaya	4082
Darwin	5377
Bowen	6649
Sydney	7622

A SONNET ON KARACHI

CITY of soothing breeze and sea-born rocks,
Of sacred Sindhu and the surging sea,
Karachi, on thy young ship-ridden docks
Alladin's magic rays have fallen free
And even now we boast of palaces!
So soon thou art a rose in Bharat's hair,
Thy Clifton's lovely pier low sea-waves kiss,
While dazzling skies laugh at the sands elsewhere!

City of hopes! Learn wisdom from the past
And do not share the vanished ones' sad fate;
Spread on thy bosom Learning's temples vast;
Let not upon thy face hot winds of hate
Blow still but breath of providential breeze
Of brotherhood and happy harmonies!